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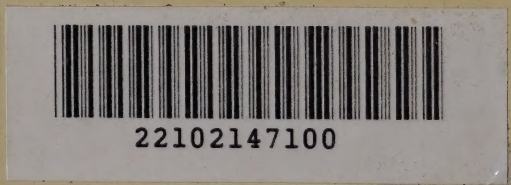
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AUSCULTATION AND PERCUSSION.

Teque auscultantem palpantem et percutientem
Pectora, sic morbi ducere signa vident.

E Carmine Roberti Bridges
De nosocomio Sti Bartolomaei Londinensi.

AUSCULTATION AND PERCUSSION:

TOGETHER WITH

THE OTHER METHODS OF PHYSICAL EXAMINATION OF THE CHEST.

BY

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PREFACE.

This new Edition has been thoroughly revised, much altered, and, I hope I may say, improved. The Table of Contents will help to show how the subject is treated. Utility has been the test applied to the many methods of physical examination. I have written in the belief that methods which are useful could not be discussed too fully; and that those which are remote from use, obscure, and subtile, might be passed over with nothing more than a reference to some place where they are described. I have taken great pains with the terminology; and have, for the most part, used technical words with a strict adherence to their original meaning.

Much of the difficulty of teaching Auscultation and Percussion to students is due to neglect of this plain rule,* which everyone who uses such words may be expected to follow, or to give good reasons for not following.

LONDON,
Jan. 19, 1883.

* Upon this topic, compare Berkeley (Hylas and Philonous, 2nd dialogue; "Tell me, Hylas," etc.) with Bacon (Advancement of Learning: 2nd book: On natural philosophy; "But to me, on the other side," etc.). I much prefer the bishop's doctrine to the chancellor's.

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PHYSICAL EXAMINATION OF THE CHEST.

INTRODUCTORY.

PHYSICAL EXAMINATION AND PHYSICAL SIGNS.

PHYSICAL Examination relates to those phænomena which a person examining can discover for himself, and without help from the person examined. Most parts of the body may undergo a physical examination; the immediate results thereby obtained are called Physical Signs.[1]

The present book is devoted to an exposition

[1] "When a man hath so often observed like antecedents to be followed by like consequents, that whensoever he seeth the antecedent, he looketh again for the consequent; or when he seeth the consequent, maketh account there hath been the like antecedent; then he calleth both the antecedent and the consequent, *signs* one of another." Hobbes: Human Nature, Chap. IV. par. 9. Cf. Computation or Logic, Chap. II., par. 2.

of the methods and results of physical examination of the organs contained in the thorax; namely, of the lungs and pleuræ, the heart and pericardium, and the mediastinum, including the large bloodvessels.

The First Part treats of the physical signs considered in the abstract; the pure science of the physical signs.

The Second Part treats of the physical signs considered in their subservience to the discovery of disease; the applied science of the physical signs.

PART THE FIRST.

CHAPTER I.

METHOD OF EXAMINATION.

SUPPOSE a patient with the chest exposed, ready to undergo a physical examination: the physician first of all carefully surveys the chest with his eye, this is Inspection: next, with his hand, this is Palpation: he next strikes the chest, Percussion: and lastly he puts his ear to the chest, Auscultation.

Whenever convenient, the patient should remove all clothes from the upper part of the body down to the waist, and stand opposite to the physician. Needful deviations from this rule will be suggested by the good sense of the examiner at the proper time and place. Children who are not able to stand strongly should be stripped naked and held in the arms of a

nurse. The physical examination of children is not more difficult than that of older persons: and the method in all cases is the same.

CHAPTER II.

INSPECTION.

INSPECTION discovers the shape of the chest. First; the shape such as it is when the thorax is at rest; that is to say, at the end of an ordinary expiration and during the diastole of the heart. Secondly; the ceaseless temporary changes in shape which the chest undergoes during life, in consequence of the respiratory and circulatory movements.

SECTION I.

SHAPE OF THE CHEST AT REST.

A transverse section of the chest upon a horizontal plane approaches to the figure of an ellipse; between the long and short axes of which (that is to say, between the breadth and depth of the chest) there is a certain proportion. Knowledge of this proportion is the key to knowledge of the shape of the chest in health,

and the unilateral and bilateral changes which that shape undergoes in disease. Changes in the length or height of the chest from above downwards, changes in the direction of the ribs, in the width of the intercostal spaces, in the size of the costal angle, in the arching of the spine and sternum, in the height of the shoulders, and in the projection of the shoulder blades; all these have a definite relation to changes in the shape of the horizontal ellipse.

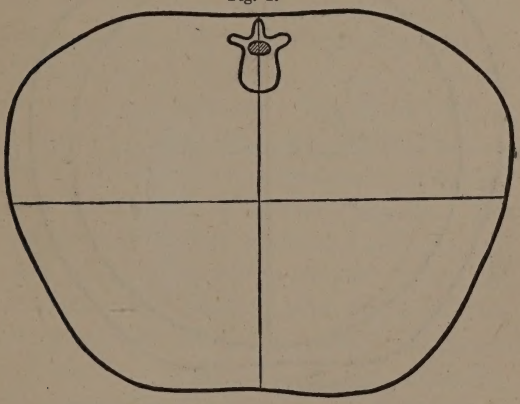
When the axes of the ellipse are nearly equal in length, and the horizontal plane is nearly circular in outline, the chest is short from above downwards (the floating ribs being excluded from consideration), the ribs approach the horizontal, the intercostal spaces in front are narrow, the costal angle is obtuse or open, the sternum is arched, the shoulders are high, and the scapulæ lie flat on the ribs. On the other hand, in proportion as the transverse axis of the ellipse exceeds in length the anteroposterior, the chest becomes long, the ribs slope downwards, the intercostal spaces in front are wide, the costal angle is acute, the sternum is straight, the shoulders are low, and the corners of the shoulder-blades project from the ribs. The former is the chest of inspiration or expansion,

the latter is the chest of expiration or contraction.

Article I.—Shape in Health.

We may conceive an idea or a type of what the perfect human chest should be. But the

Fig. 1.



Circumference = 89 centimeters.

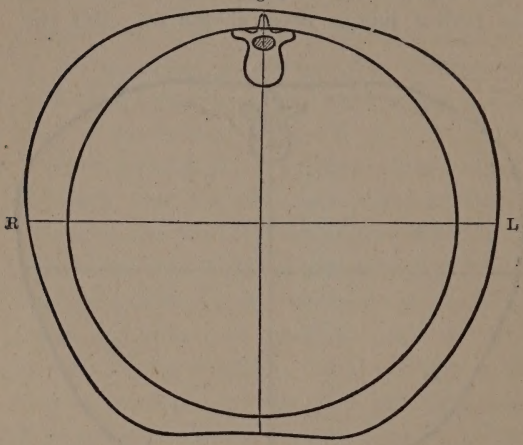
Transverse section of healthy adult chest upon level of sternoxiphoid articulation.

ideal shape is seldom realised: deviations from the type are present in nearly all persons, who nevertheless may be in soundest health. The more important of these deviations I shall describe under the title of subtypical.

¶ 1.—THE TYPICAL SHAPE.

In new-born children the axes of the ellipse are almost equal; the thorax is nearly as deep as it is broad, and is not far from circular.

Fig. 2.



Circumference = 40·5 centimeters.

Transverse section of chest of an infant aged 9 months.
(A circle drawn within the tracing for the sake of comparison.)

As growth proceeds the breadth of the chest increases more quickly than the depth; so that, by the time the child has cut his milk teeth, a strongly elliptical shape is established. The disproportion between the axes becomes greater and greater (but with diminishing rate of yearly

increase) until the body is fully developed. After maturity no further changes occur, until those morbid conditions, which are the almost necessary companions of old age, begin, in most persons, to alter the typical shape, and to make the chest acquire, in the second childhood, much the same figure that it had in the first.

The Cyrtometer is an instrument by means of which the shape of the chest may be exactly ascertained and registered. Originated, both in notion and in name, by Andry[1] and Bouillaud, it was by Woillez that the cyrtometer was first made really useful in physical diagnosis. The cyrtometer of Woillez[2] consists of a number of small pieces of whalebone rivetted together so as to form two jointed girths, which may be accurately applied to the two sides of the chest, and which are easily fastened and unfastened before and behind by a simple arrangement. I have found that a cheap and perfect cyrtometer may be made by two pieces of composition gas-pipe, drawn out to a diameter of the eighth of an inch, and united by a piece of caoutchouc

[1] So Woillez says, but gives no references.

[2] Recherches cliniques sur l'emploi d'un nouveau procédé de mensuration dans la pleurésie. Paris, 1857.

tubing. The instrument, after having been accurately applied to a given circumference of the chest, is removed, and will then afford a tracing of that circumference. The composition alloy is slightly, though but slightly, resilient: wherefore it is well to determine the anteroposterior diameter of the chest by means of calipers, and so to correct the cyrtometer before tracing the outline. The arms must hang by the sides of the chest while the cyrtometer is adapted thereto: for when the arms are raised or held forward the shape of the chest is changed. It is needless to add that the cyrtometer is the best means of measuring the chest.

In order to illustrate the statements just made respecting the different shapes of the thorax at different ages, I will give some actual measurements, taken upon the level of the sternoxiphoid joint, and so calculated that the circumference always = 100.

Age.	Actual circumference.	Ratio of diameters to circumference.	
		Antero-posterior.	Transverse.
3 months . .	$14\frac{3}{4}$ inches (37·5c.).....	26	29
2 years	18 ,, (45·75c.) ...	26	32
34 years	$29\frac{3}{5}$,, (75c.)	26	35
48 years	35 ,, (89c.)	27	31

The chests measured were all perfectly healthy, saving the last, which was emphysematous.

The semicircumference of the right half of the chest is usually a trifle greater than that of the left; the maximum of difference, on the nipple level, being an inch and a quarter. The nipples are seated on the fourth interspaces. The manubrium joins the body of the sternum at an angle, angulus Ludovici, level with the second rib.

It is convenient to regard the chest as mapped out by certain vertical lines, whereby we can indicate the exact longitudinal situation of any physical sign. The following vertical lines will be found sufficient: the midsternal, right or left side-sternal, parasternal (i.e. midway between the side-sternal and nipple lines), nipple, mid-axillary, scapular (i.e. the angle), and the vertebral groove. The horizontal level or latitude is indicated by reference to the clavicles, ribs, intercostal spaces, nipples, and sternoxiphoid articulation.

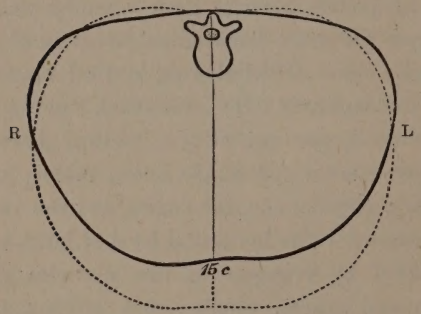
¶ II.—SUBTYPICAL SHAPES.

There are certain deviations from the typical shape of the chest which are present in a large number of persons free from any disease of the

thoracic organs. And, partly for this very reason, but chiefly because these deformities do indicate pulmonary disease in the past, or a tendency to it in the future, they are worthy of all our attention. They are of five kinds, to wit, the alar or pterygoid, the flat, the transversely constricted, the pigeon, and the rickety chests.

i. THE ALAR CHEST.—It has been known from of old that many persons predisposed to phthisis

Fig. 3.



Circumference = 59·5 centimeters.

ALAR THORAX.

Tracing taken from a child. The dotted line indicates the shape of the chest of a healthy child of the same size. The circumferential measurement refers to the alar thorax.

manifest their predisposition by an unnaturally small chest. Projection of the angles of the

scapulæ, so as to look like wings, is one sign of the small capacity of these chests, which are therefore called alar or pterygoid by Galen and Aretæus.[1] The thorax of phthinodes (persons predisposed to phthisis) is, as Galen says, narrow and shallow; the anteroposterior diameter is especially small. This diminution in caliber is brought about by drooping, or undue obliquity of the ribs, hence the shoulders fall, and the length of the thorax from above downwards is increased; it is the falling of the shoulders which causes the alar appearance. The pterygoid chest is often accompanied with a prominent throat, as Aretæus says, due to a long neck, and the head being carried unduly forwards.

ii. The Flat Chest.—The diminution in capacity presented by the alar chest does not necessitate any great change in the outline which a horizontal plane of the thorax naturally presents. But sometimes not only the size of the sectional area but its shape also is

[1] Hippocrates: Epidemics, bk. vi. sect. iii. par. 9 (edit. Foes.).

Galen: Comment. in Hippocr. Epidem. i. pag. 62 (edit. Kühn, 1828).

Aretæus: Caus. et sign. morb. chron. bk. i. ch. 8.

Boerhaave: Aphor. 1198, & Van Swieten's commentary.

changed, by the cartilages of the true ribs losing their curve and becoming straight. In which case the chest looks quite flat in front instead of being rounded, the horizontal ellipse is flattened from before backwards, nay sometimes the sternum is depressed below the level of the cartilages so that a section would be somewhat kidney-shaped, the cartilages being curved in the wrong direction. In other respects the flat chest mostly presents the characters of the alar thorax ; but this is not always the case, inasmuch as the alar appearance is due to increased obliquity of the ribs and falling of the shoulders, conditions which are not always present even in a well-marked flat chest, the diminution of capacity being otherwise brought about. Flat chests also indicate a phthisical disposition.

Both the phthinoid chests (alar and flat) are often modified in shape by the presence of the transverse constriction to be hereafter described. And both are, as Van Swieten says, essentially the same as the actually phthisical chest, but deformed to a less degree ; moreover the loss of fat and muscle which occurs in phthisis makes all the characters described more obvious.

The phthinoid chests are Natural deformities,

the tendency to which is born with the individual and inseparable from him. I now come to the Accidental deformities of the chest, those which have been produced by actual disease subsequent to birth.[1]

iii. TRANSVERSE CONSTRICTION OF THE CHEST.—A deformity from which few persons are wholly free. It consists in a depression, more or less deep, of the chest walls in front, which passes outwards and slightly downwards, on both sides, level with the xiphoid cartilage, and ceases gradually towards the mid-axillary line.

Produced during childhood, the groove simply persists in after years. Its immediate cause is an impediment of some duration to the inspiration of air sufficient to distend the whole of the chest ; the air fails to expand the bases of the lungs. Catarrh is that impediment in the vast majority of cases. Nor need the catarrh be at all severe, or the impediment at all great, inasmuch as a necessary concurrent cause of the groove is found in the yielding character of the ribs during infancy and early childhood, and

[1] "Naturalem formationem eam appello quæ sit cum pectore constricto, longo collo, et humeris alatis ; accidentalem vero quæ sit cum curvitate seu distortione pectoris." Morton : Phthisiologia ; bk. ii. chap. i. Lond. 1689

especially of ribs rendered (as they so often are) præternaturally yielding by rickets.

When the impediment is severe and protracted, the depression, although proportionally great, ceases to exist alone; other deformities are produced, and all together go to make up the pigeon breast.

But when the deformity stops short of a pigeon breast, that is, when the depression is not so great as to involve the whole of the front base of the thorax from the xiphoid level downwards, it is the abdominal viscera which determine the position of the sulcus by maintaining the expansion of the base of the chest. The depression occurs as low down as possible, namely, immediately above the upper surface of the abdominal viscera, or what comes to the same thing, the sulcus corresponds to the vault of the diaphragm. This fact led Harrison[1] to propose the sulcus as an easy means of determining the upper margin of the liver. But be it remembered that the groove indicates what was the upper margin of the liver in early life; and

[1] On physical signs. London Medical Gazette, vol. xix. p. 369, Dec. 10, 1836.

Errors of Laennec and others respecting the regions of the chest. Ibidem, p. 776. 1837.

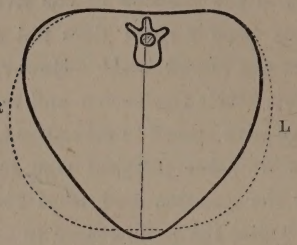
although no doubt the relationship of the parts concerned is scarcely altered in adult age, excepting from disease, yet it is clear that whatever changes the position of the liver after the furrow has been formed does not change the position of the furrow itself. However, for this very reason, albeit the groove and upper margin of the liver have ceased to correspond, the groove remains a valuable physical sign, indicative of what was the position and what the extent of the liver before the parts ceased to correspond.

iv. THE PIGEON BREAST.—The essential character of the pigeon breast is a straightening of the true ribs in front of their angles. Necessary consequences of this deviation from the natural shape are, first, that the sternum is thrown forwards, and next, that the greatest transverse diameter of the chest recedes towards the costal angles, that is, that the horizontal section tends to pass from the ellipse into the triangle.

The cause of the straightness of the ribs is a long existing or frequently recurring impediment to free inspiration while the ribs are plastic, that is, during childhood; and especially when they are præternaturally yielding, that is, when rickety. Chronic pulmonary catarrh (including

hooping cough) and chronic enlargement of the tonsils are the common causes of pigeon breast :[1]

Fig. 4.



Circumference = 57·5 centimeters.

PIGEON BREAST.

Tracing taken from a child of seven years. Dotted line indicates natural shape at same age.

by watching the chest of a child during the long-drawn inspiration of hooping cough, the deformity may be easily seen in process of formation.

But obstruction to inspiration was pronounced to be the cause of the transversely constricted chest. And so a pigeon breast is mostly accompanied by a well-marked transverse sulcus : as a part of which transverse constriction, the xiphoid cartilage becomes bent back so as to

[1] Dupuytren : Mémoire sur la dépression latérale des parois de la poitrine chez les enfants. Breschet's Repertoire générale d'anatomie : vol. v. p. 110. Paris, 1828.

form a more or less sharp angle at the bottom of the sternum; a condition which increases the similarity to a pigeon's breast. The transverse furrow, I say, is well marked; in fact, very often there is a depression of the whole anterior half of the thorax below the xiphoid level; in which case, the straightening of the false ribs, in front of the angles, is carried to an extreme degree. This flattening below Harrison's sulcus is partly due to the fact that a deep inspiration involves the upper thorax chiefly.

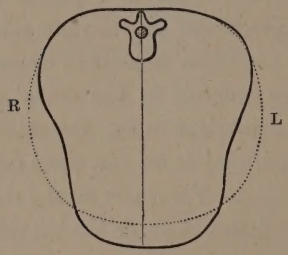
The costal cartilages of a pigeon breast are often more prominent on the right side than on the left: a condition sometimes connected with more or less scoliosis in the dorsal vertebræ; sometimes dependent upon the cause of the pigeon breast, that is to say, upon catarrh and its consequences. For where on the right side is lung, free to dilate, there, on the left side, lies the heart.

v. The Rickety Chest.—Rickets, on account of the part which it takes in the generation of the transversely constricted and of the pigeon chest, has already been alluded to more than once: it remains to show how rickets alone may produce deformity of the chest.

Rickets is a disease of infancy, and infants

cannot but have a respiration chiefly abdominal, because of the circular shape of their thorax, which does not admit of further horizontal expansion. When the diaphragm descends and rarefies the air contained in the lungs, the rickety ribs, not being able to hold out until the chest is completely distended by fresh air passing in through the glottis, yield in their softest parts to the atmospheric pressure from without, and are bent inwards. Inasmuch as the

Fig. 5.



Circumference = 42·75 centimeters.

RICKETY CHEST.
Dotted line indicates shape of chest in an infant of about the same age.

softest parts of the ribs are at and near their costochondral articulations, a shallow longitudinal groove is formed on each side of the

chest, more or less parallel with the sternum and ending just above the costal margin: a groove which may be formed without the least direct impediment to the entry of air through the air-passages.

But in rickets the whole ribs are softened more or less, and hence when the causes of a transverse groove or of a pigeon breast are present in a rickety child, the resulting deformity is exaggerated.

Deformities of the chest which are purely rickety tend to disappear to a remarkable degree as the health improves: deformities of more complex origin are more permanent.

Article II.—Shape in Disease.

Having described the deviations from the natural shape of the chest which are compatible with a healthy state of its contents, I now come to those changes in shape which indicate disease of the thoracic viscera. Changes of this latter kind may be reduced into three classes, namely, bilateral, unilateral, and local. The former two classes of change indicate disease of the lungs or pleuræ: the last class of change may be caused by disease of lungs, heart, serous membranes, or mediastina.

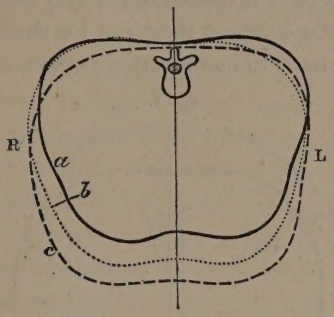
¶ I.—BILATERAL CHANGES IN SHAPE :

are of two kinds, enlargement and diminution.

i. BILATERAL ENLARGEMENT.—By the deepest inspiration (in other words, by the greatest elevation and rotation of the ribs) no considerable modification can be produced in the proportion between the length of the two axes of the horizontal ellipse. In order to render further enlargement of the thorax possible the ribs must change their shape ; they become more curved : the axes of the ellipse tend to become equal ; the ellipse tends to pass into the circle ; changes which are explained by the fact that of all figures possessing a periphery of fixed and certain length, the circular is that which includes the greatest area ; depart from the circle in any way and the area becomes less. It is a fact which must be clearly understood ; that the chest admits of an enlargement far beyond that which can be produced, when the lungs are healthy, by the deepest inspiration. It is a mistake to suppose that the bilaterally enlarged chest is merely in a state of permanent inspiratory expansion. The experiment indicated by the diagram on the next page is decisive upon

this point. Moreover Freund[1] has shown that, in an emphysematous chest, there is sometimes

Fig. 6.



Horizontal section of chest of a child two years old.

a = chest at rest.
b = chest after fullest expansion possible of lungs.
c = chest after forcible injection of air into both pleural cavities.
Anteroposterior diameters:

a = 10·2c. *b* = 11·7c. *c* = 13·2c.

Circumferences:

a = 47·5c. *b* = 48c. *c* = 48·5c.

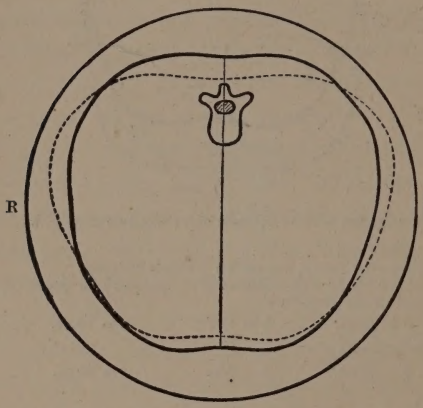
an actual increase in the length and breadth of the costal cartilages.

Enlargement of the chest signifies enlargement of its contents: the only necessary associates of bilateral enlargement are emphysema

[1] Der Einfluss der primären Erkrankungen des knorpligen Thorax auf Entstehung gewisser Lungenkrankheiten. Würzb. Verhandl. 1859. Bd. ix. p. 223.

of the lungs (whether a permanent, or a merely temporary distension of the air-vesicles), and a large effusion of fluid into both pleuræ. Now the latter state is incompatible with life, and so a bilaterally enlarged chest and the chest of emphysema come to be convertible terms.

Fig. 7.



Bilateral Enlargement of Emphysema.

Inner line = emphysematous chest.
Outer line = a circle drawn to show how nearly the emphysematous approaches the circular shape.
Dotted line = natural adult chest.
Actual measurements in centimeters:

Circumference	= nat.	89·	emphys.	87·75
Transverse	= ,,	29·6	,,	27·25
Anteroposterior	= ,,	22·25	,,	25·4

In a well-marked case of emphysema, then, the thorax is in a state of distension beyond

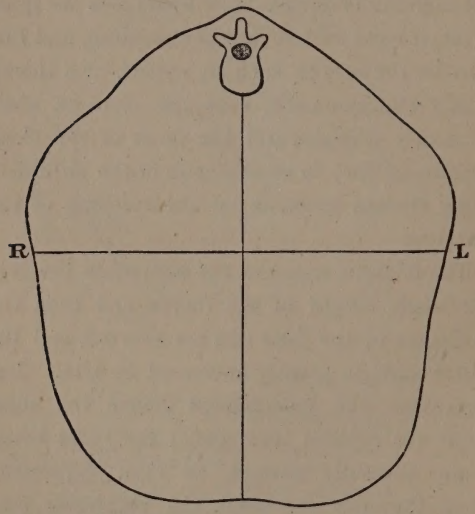
what could have been produced during health by the deepest possible inspiration. The chest is almost cylindrical or globular, arched before and behind. The arching is usually most marked in the sternum, and is simply the result of the fact that the sternum is less able to move forwards above than below: the manubrium and body of the breast-bone become bent at an angle, the angulus Ludovici. But sometimes the spine is much more arched than the sternum, and this may be the case to such an extent, in a thorax highly emphysematic, that the sternum shall be nearly straight, and the front of the chest apparently flat, in consequence of the shoulders being thrown forwards by the stooping of the vertebræ.

The bilateral enlargement sometimes involves the whole length of the thorax, and then the cartilages of the false ribs are everted, and the costal angle is greatly increased in size. But sometimes the enlargement affects the chest above the xiphoid level only; the parts below being tolerably natural, or even depressed: when they are depressed, the transverse constriction is well marked, and the costal angle is diminished in size. The causes of the depression are the same as described when speaking of

pigeon breast; very little air enters, what does enter goes to the upper parts; the respiration is superior-thoracic. Indeed, this shape is usually due to subsequent bilateral distension of the upper part of chests which were wholly pigeon breasted early in life.

Habitual stooping is attended by a shape of

Fig. 8.



SHAPE OF CHEST IN ANGULAR CURVATURE.

Circumference = 79·75 centimeters.
Transverse diameter = 22· ,,
Anteroposterior diameter = 26·5 ,,

Tracing taken from a man aged fifty-two years.

chest which strongly simulates emphysematous enlargement. Vertebral caries sometimes goes farther still, and reverses the natural shape of the chest, so that the anteroposterior diameter comes to exceed the transverse.

In the acute emphysema of the anterior part of the lungs, which attends the suffocative bronchitis of children, a bilateral distension of the front of the chest may take place in a day or two. When the catarrh becomes chronic, the time is often long before the chest regains its natural shape.

ii. BILATERAL DIMINUTION.—The diminution is greater than can be produced in a healthy chest by the deepest expiration. The characters of the chest are in all points the same as those of the flat phthinoid chest but carried to a greater pitch. Phthisis is the only disease in which great diminution of both sides of the thorax occurs; as Aretæus says,[1] the chest becomes broader (*i.e.*, in the transverse diameter), yet the patients stand in need of its being broader still (*i.e.*, in the anteroposterior diameter).

Paralysis of the diaphragm causes bilateral

[1] Caus. et sign. mb. diut. bk. i. chap. 10.

enlargement of the chest; paralysis of the intercostals, bilateral diminution.[1]

¶ II. UNILATERAL CHANGES IN SHAPE.

These, like the bilateral, consist in enlargement and diminution.

i. UNILATERAL ENLARGEMENT.—The notes of bilateral enlargement already given are applicable to enlargement of one side only of the chest. The side enlarged, compared with the other, will present these characters: shape rounder; transverse semidiameter shorter, and anteroposterior diameter longer; length, from above downwards diminished, shoulder raised; spine curved towards unaffected side. I say that the length of the chest from above downwards (the vertical diameter) is diminished, and this is true, provided that the floating ribs be excluded from consideration: let anyone who doubts this statement inject the pleura of a dead subject with air, and watch the changes which ensue. The anteroposterior enlargement becomes very obvious when the physician stands behind the patient so as to look obliquely over

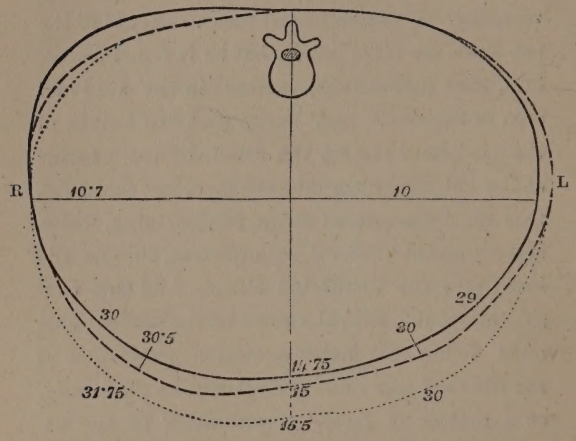
[1] Duchenne: De l'électrisation localisée: 3me édit. p. 515. 1872.

his shoulders and the front of his chest. In children the best notion of the enlargement and roundness of the affected side is gained by grasping both sides with the two hands, the thumbs being placed tip to tip upon the spines of the vertebræ. Circumferential measurements of the two sides are often made, but be it remembered, first, that considerable increase in the sectional area of the chest may occur, and the length of the periphery remain the same, by the passage of the elliptical form into the circular: and next, that the displacement of the mediastinum, which accompanies unilateral enlargement, thrusts the heart into the unaffected side. Add this consideration, too, that the walls of the healthy side must follow the anteroposterior projection of the diseased side: and then it will be plain why, as a matter of fact, the perimeter of the expanded side often measures very little more, nay even less, than that of the side which is not diseased. The cyrtometer alone, by indicating shape as well as circumference, affords us the true means of recording the amount of a unilateral enlargement.

The causes of bilateral and unilateral enlargements are the same, namely, increase in the size of the lung, and effusion of fluid into the

pleura. Increase in the size of one lung occurs in vicarious hypertrophy compensatory of chronic disease whereby the other lung is put out of

Fig. 9.



Unilateral enlargement of chest (right side); artificially produced by injecting air into the right pleural cavity.

Unbroken line = outline before injection.
Broken line = outline after moderate distension.
Dotted line = outline after extreme distension.

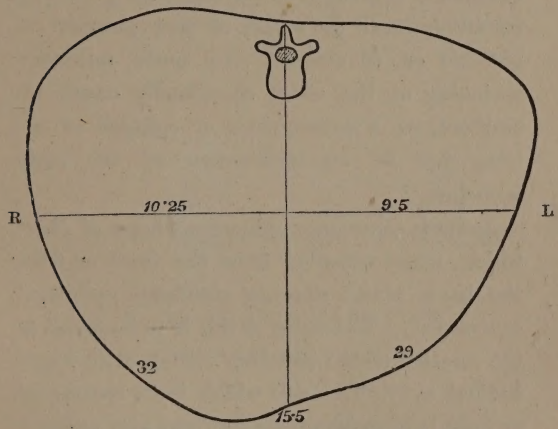
Figures, at bottom of vertical line indicate the anteroposterior diameters: along horizontal line indicate transverse semidiameters: remaining figures indicate right and left semicircumferences.

play: unilateral hypertrophous emphysema, the other lung being healthy, is not found. Effusion of fluid into the pleura, however, causes the

greatest enlargement: inflammatory effusion, pneumothorax, extensive hæmothorax.

ii. Unilateral Diminution.—In unilateral shrinking of the chest the circumference and the anteroposterior diameter are diminished;

Fig. 10.



Unilateral retraction of chest: consequent upon cirrhosis of left lung in a girl of fourteen. Figures as in last sketch.

the transverse diameter increased; the side looks flat before and behind, having lost its rounded shape and become angular; the ribs are closer together than natural; the shoulder is lower; and the spine curved towards the healthy

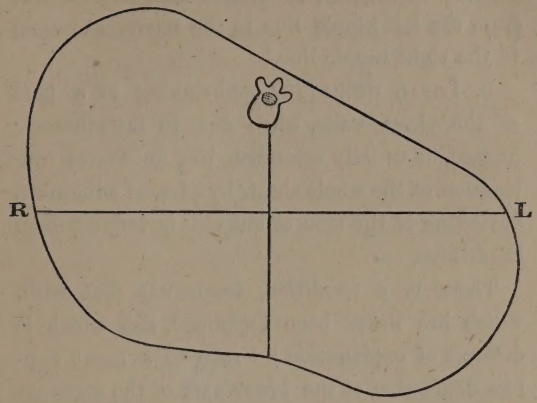
side. The perimeter of the contracted side is diminished; and, when there is vicarious enlargement of the other lung, the difference between the circumference of the two sides becomes very great.[1]

Unilateral diminution of the chest, when chronic, is attended by an adherent pleura; a condition itself the result of past pleurisy, of phthisis or of cancer. An acute unilateral shrinking of the chest occasionally occurs in children, as a consequence of collapse of one lung due to an obstruction of the main bronchus.

Scoliosis sometimes induces a shape of chest which, when regarded from the front or from the back alone, strongly simulates unilateral contraction. The cause of this is to be found in the rotation of the vertebræ round their longitudinal axis. The side which looks contracted in front is protuberant behind, and vice versa.

[1] In a case of excessive unilateral contraction of the chest, consequent upon empyema, and associated with distension of the other side, I noted that a very powerful inspiratory expansion and forward movement of the distended side was accompanied with distinct recession and backward movement of the front of the contracted side, as if it were drawn upon and straightened.

Fig. 11.



SHAPE OF CHEST IN SCOLIOSIS.

From a girl aged eight years and a half. One-third the natural diameter.

¶ III.—LOCAL CHANGES IN SHAPE,

namely local bulging and shrinking.

i. LOCAL BULGING.—Bulging of a part of the chest walls is met with in circumscribed pleural effusions, in pericardial effusions, in large phthisical excavations, in hernia of the lung, in hypertrophy and dilatation of the heart, in pointing empyemata, in aneurysms, in cancerous, hydatid, and other tumours.

The bulging indicative of cardiac or pericardiac enlargements occurs between the third and

seventh cartilages on the left side, and extends from the left nipple line to the sternum or even to the right nipple line.[1]

ii. Local Shrinking.—Shrinking of a part of the chest walls, when due to intrathoracic disease, is usually attended, like unilateral contraction of the whole chest, by pleural adhesions. Shrinking of the apex of one side is very common in phthisis.

There is a condition, frequently met with, which has never been explained, and which is difficult of explanation; I refer to a great cup-like depression of the lower part of the sternum and of the attached cartilages.[2] The pit is sometimes so broad as to reach up to the level of the third rib; and sometimes so deep that it seems as if the bottom must almost touch the spinal column. I have known this deformity to follow unilateral pleurisy, and yet to be perfectly symmetrical; even although one side only of the chest was contracted. Pericardial adhesion,[3] like-

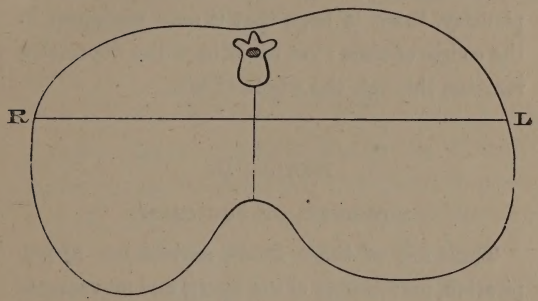
[1] Norman Moore has studied this form of bulging with the help of the cyrtometer. Observations on the shape of the chest in cases of hypertrophy of the heart. London, 1873.

[2] In the Museum of St. Bartholomew's Hospital there is a fine skeleton showing this deformity: Case B., No. 109.

[3] Copland: A Dictionary of Practical Medicine. Vol. ii. p. 214, 1844—1858.

wise, may cause a hollow of this kind. Hooping cough will do the same. Croup, in infants, is

Fig. 12.



CUP-SHAPED DEPRESSION.

From a man aged eighteen years. Tracing taken on level of xiphoid, and reduced to one-fourth the natural diameter.

often attended by enormous inspiratory recession of the whole corpus sterni below the angulus Ludovici: whence I infer that a chronic catarrhal obstruction to inspiration may cause, in some cases, this crateriform depression instead of the more usual pigeon breast: the angle produced by the horizontal constriction occurs higher up than usual. Rickets, no doubt, would be auxiliary. A slight degree of a similar deformity is found in many shoemakers: in whom it is due to pressure from without. Graves tells

of a young man whose sternum was so yielding that it could be easily pushed back so as to make a cupping just such as I have described.[1] When the deformity follows hooping cough or pleurisy, there is hope that it may disappear in the course of time : yet sometimes the depression remains through the whole of life.

SECTION II.

MOVEMENTS OF THE CHEST.

These are of three kinds, movements of respiration, movements of the heart, and movements wholly unnatural.

ARTICLE I.—MOVEMENTS OF RESPIRATION.

¶ I.—IN HEALTH.

Healthy breathing and its varieties, according to age and sex, are subjects so fully discussed by physiology that they may be passed by in this place.

Great is the number of instruments which have been invented for registering the respiratory movements and powers : stethographs, stetho-

[1] Clinical Lectures on the Practice of Medicine. 2nd edit. vol. ii. p. 521, Lecture 68. Dublin, 1848.

meters, thoracometers, spirometers, pneumatometers, anapnographs: a field of study which seems to be uncommonly barren, if we compare the outlay of toil and wit with the scanty yield to diagnostics.[1]

¶ II.—IN DISEASE.

Mere increase and mere diminution of respiratory movement, bilateral, unilateral, or local, scarcely demand a long notice. Perversions in the character of the movement are more important: they may be arranged under five

[1] The literature of the subject may be found in the following books :—

Ransome : On Stethometry ; being an account of a new and more exact method of measuring and examining the chest, with some of its results in physiology and practical medicine. London, 1876. Also : Med. Chir. Transactions. Vol. 64, p. 185. London, 1881.

Riegel : Die Athembewegungen. Würzburg, 1873.

Waldenburg : Die pneumatische Behandlung der Respirations, und Circulations-krankheiten im Anschluss an die Pneumatometrie, Spirometrie, und Brustmessung. Berlin, 1875.

Abernethy was the first to propose the use of a spirometer : see Young : On Consumptive diseases, p. 21. London, 1815. The pneumatometer of Marshall Hall measured the chemical changes undergone by breathed air. London Med. Gazette, vol. xi. p. 850 : 1833.

heads, inspiratory dyspnœa, expiratory dyspnœa, non-expansive inspiration, respiration wholly thoracic, and respiration wholly abdominal.

i. Inspiratory Dyspnœa.—It is when the chest-walls are yielding that inspection affords the most convincing sign of inspiratory dyspnœa; namely, a recession, more or less deep, of the front of the thorax below the level of the nipples. The causes and mechanism of this recession are identical with the causes and mechanism of the transversely constricted chest. But I speak now of an amount of constriction so great as to be incompatible, for any length of time, with life. Inspiratory dyspnœa, such as this, occurs in obstruction to the passage of air through the larynx or trachea, in per-acute œdema of the lungs and hydrothorax, and in infants or rickety children even during a common pulmonary catarrh. In the last case, temporary bilateral enlargement of the chest, above the transverse sulcus, mostly concurs with the depression of the parts below. Even unilateral diseases, such as empyema and plugging of a bronchus, are sometimes attended in children by the bilateral results of inspiratory dyspnœa described above, namely, by great and equal recession of the base of the chest on both sides. In obstruction to

the larger air-passages the supraclavicular regions usually partake in the recession.

ii. EXPIRATORY DYSPNŒA.—In this condition the expiratory movement is exceedingly laborious and prolonged. Expiratory dyspnœa is present along with any great impediment to expiration in the upper air-passages; and also occurs whenever the expiratory power of the lungs is diminished, as in emphysema, asthma, and congestion.

iii. NON-EXPANSIVE INSPIRATION.—The chest-walls are elevated powerfully, yet expanded little or not at all. This sign may occur, on one side or on both, whenever the texture of the lung is impermeable to air, or non-expansible (as in pleurisy with effusion, pneumothorax, dense pleural adhesions, phthisis, and cancer), or when the thorax cannot be dilated more than it is (as in emphysema).

iv. RESPIRATION WHOLLY THORACIC. — The female type of respiration carried to the extreme. Occurs in diseases which interfere with the action of the diaphragm: paralysis of the diaphragm, great pericardial effusion, peritonitis, ascites, abdominal tumours.

v. RESPIRATION WHOLLY ABDOMINAL. — The male or infantine type of respiration carried to

the extreme : respiration being performed almost wholly by the diaphragm. Occurs bilaterally in spinal paralysis and in tetanus ; unilaterally in pleurodynia, pleurisy, phthisis.

Article II.—Movements of the Heart.

The chief movement of the heart, detected by inspection, is the Impulse. Systolic recession of certain interspaces is sometimes visible.[1]

¶ I.—movements in health.

i. The Impulse.—The movement of any part of the heart, which underlies the chest-walls, may be seen and felt in favourable circumstances. But there is commonly only one impulse in health. The part of the heart which strikes the chest wall appears to be a spot upon the anterior surface of the right ventricle, about three-quarters of an inch above the apex : the apex itself being separated from the thoracic parietes by a layer of lung which is a finger broad.

The Time of the impulse coincides, not with the contraction of the ventricles only, but with

[1] Throughout this book, the word "systolic" means contemporaneous with the systole of the ventricles ; "diastolic," with their diastole.

the contraction of the auricles, of the ventricles, and the closure of the semilunar valves. Wherefore the impulse is not exactly systolic, as is commonly taught, but is also præsystolic and postsystolic.[1] Nevertheless it is generally accurate enough to deem the impulse simply systolic.

The Position of the impulse is the fifth left interspace, midway between the nipple and the parasternal lines. In children, under eleven years of age, the heart frequently lies high, so that the impulse occurs in the fourth interspace, and rather more external than in adults, that is to say, in the nipple line. In many old people the heart lies low, so as to beat against the sixth interspace. By a deep inspiration the impulse can be depressed half an inch. By lying upon the left side the position of the impulse shifts to the nipple line or beyond it. By lying upon the right side the position of the impulse becomes uncertain.

The Extent of the visible impulse is small, not greater than a square inch.

The Force of the impulse is best estimated by palpation.

Epigastric pulsation, conducted from the

[1] Landois: Graphische Untersuchungen über den Herzschlag im normalen und krankhaften Zustande; p. 71. Berlin, 1876.

right ventricle, may be caused by a healthy heart throbbing from violent exercise or emotion.[1]

ii. Recession of the Chest Walls.—Is occasionally perceptible, during the systole, in the third, fourth, or even the fifth intercostal spaces on the left side, close to the sternum: this, especially in persons who are very thin.

¶ II.—MOVEMENTS IN DISEASE.

i. The Impulses.—Three kinds of impulse are seen in disease: namely the apex-beat proper, more or less changed in its characters: an impulse of some part of the right ventricle above the apex-beat, especially the conus arteriosus; and an impulse of the right auricle.

a. Impulse of the apex-beat.

The Position of the apex-beat may be changed by whatever enlarges the heart or displaces it.[2]

Enlargement of the left ventricle causes the apex-beat to shift to the left of the left nipple line, in the fifth, sixth, or seventh interspace.

[1] The topic of epigastric pulsation is discussed in chap. 6, sect. 4.

[2] Consult the chapters on the Position of the Diaphragm, and of the Mediastinum, with reference to displacements of the heart.

Enlargement of the right ventricle has one or both of two effects. First: the extent of the impulse to the right of the left parasternal line is increased; for the cardiac enlargement causes the lungs to shrink away, so that the impulse of other parts of the right ventricle than the apex-beat comes to the surface, and is seen and felt. Next: the apex-beat may be displaced to the left; the heart retaining its natural position, and the left ventricle being natural in size, but the right ventricle and both auricles being greatly dilated.[1]

Displacement of the heart to the left may be so great as to cause the impulse to beat in the axillary line, and in any interspace from the second to the fifth or sixth. The causes of this kind of displacement are the following: diseases of the abdomen (ascites, tympanites, tumours) whereby the diaphragm is raised, and the heart comes to lie more horizontally than is natural; effusions of air or liquid into the right pleura; tumours to the right of the heart; retraction of the left lung, whether by phthisis, induration or old pleurisy.

[1] Markham: A case of disease of the heart, with great dilatation of the auricles. Medico-chirurgical Transactions, vol. xl. 1857.

Displacement of the heart to the right may cause the impulse to be seen anywhere to the left of the right nipple line, in any interspace from the fourth to the seventh, or in the epigastrium. The causes are similar to those of displacement to the left, excepting abdominal enlargement. And, whatever may be the case in dislocations of the heart rapidly produced, there is no doubt that chronic disease may displace the heart so that its very apex-beat shall be felt in the right nipple line.[1]

β. Impulse of the conus arteriosus.

Yet when the impulse of a diseased or displaced heart is seen to the right of the natural position, it is often some part of the ventricle, other than the apex, which strikes against the chest; and this part is usually the conus arte-

[1] Case of pyopneumothorax: St. Bartholomew's Hospital post-mortem book; Sarah B., 22 years old: March 6, 1872. Great bulging of left chest. Abdomen opened: diaphragm greatly depressed, convex downwards. The heart being fixed by a long needle before the thorax was opened, the mediastinum was found altogether forced over to the right, so much so, that the left margin of the heart was two and a half inches to the right of the midsternal line; and the whole heart lay to the right of the costo-chondral articulations of the third and fourth right ribs. In left pleura, two quarts of pus, and much air.

riosus.[1] A white patch, telling of long friction, is often seen at this spot after death.

γ. Impulse of the right auricle.

A systolic impulse seen in the fifth interspace and the right parasternal line may be due to a dilated right auricle.[2] In the case referred to below, the impulse was systolic with respect to the ventricles, and the walls of the auricle were almost destitute of muscular fibre: so that the most probable cause of the impulse was a sudden filling of the auricle with blood during the ventricular contraction.

The Extent of the impulse (meaning thereby actual contact of the heart with the chest-wall) may be increased; and then the movement sometimes takes on a fluctuating or peristaltic character. The causes of a too extensive impulse are these: enlargement of the heart, the lung being pushed aside; shrinking of the lung; and whatever presses the heart against the chest-wall, for instance a narrow chest, or a tumour in the posterior mediastinum, especially an aneurysm of the descending aorta.

[1] R. D. Powell: Notes on displacements of the heart. British Medical Journal, July 17, 1869.

[2] Markham's case, before cited. An aneurysm of the ascending aorta may beat in exactly the same situation.

ii. Recession of the Chest-wall.—The recession of the chest above the apex-beat is much more frequently met with in hypertrophy of the heart than in health. The apex-beat itself is sometimes strongly dimpled inwards during the systole; a sign which was formerly thought to indicate the presence of pericardial adhesion, combined with pleural adhesions over the pericardium; but which is now known to be of small practical value.[1]

Article III.—Movements wholly unnatural.

Movements, that is to say, which have no counterpart in the healthy state. The pulsation of aneurysmal tumours is of this kind.

[1] Galvagni: Papers quoted in Virchow and Hirsch's Jahresbericht for 1869, vol. ii. p. 75; and for 1873, vol. ii. p. 137.

Widmann: Ueber systolische Einziehungen der Intercostalräume. Virchow's Archiv, vol. lxx. p. 438: 1877.

CHAPTER III.

PALPATION.

PALPATION, or the application of the hand to the surface of the chest, is often useful as a means of confirming the notions acquired by the eye concerning the shape, size, or amount of movement of any part of the thorax. But palpation has an independent value, and can detect thrills and impulses which are imperceptible to the eye. These signs will be considered in order as they relate to the lungs and pleuræ, the heart and pericardium, and the large bloodvessels.

SECTION I.

LUNGS AND PLEURÆ.

ARTICLE I.—THE VOCAL THRILL.

¶ 1.—IN HEALTH.

When a person speaks, a tremulous sensation may often be felt upon the surface of the chest: the vocal thrill. The intensity of the thrill is in direct proportion to the depth and loudness

of the voice, and therefore is best marked in adult men, and is often absent in women and children. The reason of this seems to be that only in low-pitched notes are the vibrations sufficiently far apart to be perceptible to the hand. The thrill is conducted from the larynx both by the tissues and by the air in the air-passages: it is strongest over the lungs, and is weakened as we pass away from them: the thoracic walls conduct the thrill well when they are not very fat or œdematous. Vocal thrill is naturally more intense on the right side than on the left.

In examining the vocal thrill it is best to make all patients repeat the same sound: the words 'ninety-nine' said in as low a tone as possible are very suitable for the purpose.

¶ II.—IN DISEASE.

i. The vocal thrill is diminished or abolished by whatever separates the lung from the chest-wall, and by whatever renders the lung quite impermeable to air. An effusion into the pleura, whether of liquid[1] or gas, is a common cause of loss of vocal thrill; but, unless the effusion be

[1] This fact seems to have been discovered by Reynaud: see the memoir quoted under the head of Pleural Friction.

great, the thrill is not wholly abolished, being conducted by the thoracic walls. Solidification of the lung does not materially diminish vocal thrill, except the solidification be very dense. Wherefore ordinary pneumonic and phthisical consolidations do not lessen the thrill, and may even increase it: but pneumonic exudation which packs the lung hard, massive phthisical solidification, and cancer, these abolish vocal thrill unless indeed a large bronchus be in intimate connection with the solid mass.

ii. The vocal thrill is increased by consolidation which is not too dense, and which is traversed by large open air-tubes.

The thrills produced by cough and rales are of no practical value.

Article II.—Pleural Friction:

May occasionally be felt, but is of no practical importance.

Article III.—Fluctuation.

Fluctuation of a liquid effusion in the pleura may sometimes occur.

i. Fluctuation produced by striking the chest is an uncommon, and unnecessary, sign, inas-

much as a diagnosis will have been attained long before the disease has gone so far as to yield the sign of fluctuation. When the intercostal spaces are widened and rendered tense, fluctuation may sometimes be produced and felt by two fingers placed far apart in the same interspace. The splash of hydropneumothorax may be sometimes felt, but is much better heard.

ii. Fluctuation of a pleural liquid effusion is occasionally produced by the action of the heart: for the diagnosis of this condition see the chapter on empyema.

SECTION II.

HEART AND PERICARDIUM.

ARTICLE I.—THE IMPULSE.

¶ I. SYSTOLIC IMPULSES.

Palpation will serve to confirm the information yielded by the eye as to the position and the extent of the impulses of the heart against the chest wall. Sometimes an impulse is palpable when it is not visible.

Palpation moreover enables us to say whether the force of the impulse is weaker or stronger than natural.

i. The force of the impulse is diminished by whatever weakens the heart, and by whatever separates it from the chest-wall.

ii. The force of the impulse when increased, that is to say, a heaving impulse, is much better appreciated by applying the stethoscope and head to the apex-beat, than by the hand alone.[1] A knowledge of this fact was the immediate forerunner of the discovery of auscultation. When the heaving impulse is well marked, it is able to overcome the greatest pressure which the patient can bear, and may be regarded as a sure and certain sign of cardiac hypertrophy. It is seldom difficult to distinguish the knocking of a palpitating heart from true heaving.[2]

The force of an impulse is much influenced by the thickness of the thoracic parietes, the position of the body, and the relative situation of the lungs.

The Cardiograph (an instrument invented by Chauveau and Marey,[3] whereby the movements of a cardiac impulse may be registered) has

[1] Laennec : Auscult. médiate. 2nd edit., vol. ii. p. 394.

[2] Laennec : ibidem, vol. ii. p. 397.

[3] Chauveau et Marey : Démonstration nouvelle du mécanisme des mouvements du cœur par l'emploi des instruments

confirmed or revealed the truth of the following propositions :—

That the contraction of the auricles immediately precedes that of the ventricles: That the systole of both ventricles is exactly synchronous: That the impulse coincides with the contraction of the auricles and ventricles, and the closure of the semilunar valves: That the second sound follows immediately upon the ventricular systole: That the auriculo-ventricular valves vibrate during the greater part of the ventricular systole: That the closure of the aortic semilunars precedes that of the pulmonary semilunars.

¶ II.—DIASTOLIC IMPULSES.

Diastolic cardiac impulses are of two kinds :

i. Sudden relaxation of the ventricles, after a powerful contraction, sometimes causes a sort of diastolic impulse : the back-stroke, as it was called by Hope.[1] This most frequently occurs in hypertrophied hearts.

enregistreurs à indications continues. Mém. de l'Acad. de Méd. Paris, 1861.

[1] A treatise on the diseases of the heart and great vessels. 3rd edit. pp. 67, 272. London, 1839.

ii. Sudden closure of the pulmonary sigmoid valves sometimes causes a sharp invisible diastolic impulse, which is to be felt at the second left interspace close to the sternum. This sign indicates the presence of solid lung over the pulmonary artery, or that the lung has shrunk away from it, or that there is an unusually high pressure in the artery. The last cause is the commonest; is usually present in disease of the mitral orifice, and occasionally even in perfect health; and is attended by a loud pulmonary second sound.

¶ III.—PRÆSYSTOLIC IMPULSE.

It is said that the contraction of the auricles, when they are much hypertrophied, may give rise to a short præsystolic impulse above the fourth cartilage, and either to the right or to the left of the sternum. An auricular impulse which is systolic, the auricle being passive at the time, has already been referred to (p. 45).

ARTICLE II.—VALVULAR THRILLS.

A valvular thrill is a quivering sensation felt by the hand applied to the region of the heart

in certain forms of disease. The likeness to the purring of a cat led Laennec[1] to invent the name "frémissement cataire" for the phænomenon: by its discoverer, Corvisart, it had been before described under the term "bruissement."[2] For a thrill to be of value as a physical sign it must be well marked: what may be considered a well-marked thrill can be learnt by experience alone.

Thrills are palpable murmurs, and are due to the same physical condition; that is to say, to the vibration of a fluid vein. The vibration must be strong and slow in order to be palpable. The solids also must be apt for conduction; in other words, apt for convibration: they must be elastic, tolerably homogeneous, and of a certain mean tension. Along fluid currents, thrills are conducted according to the laws of murmurs.[3] Thrills, like murmurs, are of many kinds, and must be distinguished according to their place and time: thus—

[1] Traité de l'auscultation médiate et des maladies des poumons et du cœur. 2nd edit. vol. ii. p. 448. Paris, 1826.

[2] Essai sur les maladies et lésions organiques du cœur et des gros vaisseaux. 2nd edit. p. 232. Paris, 1811.

[3] Refer to the article on Murmurs in general, and to that on the conduction of Percussion sounds.

i. Thrills felt in the second right intercostal space, close to the sternum, or at the episternal notch: indicative of a lesion at the aortic orifice. Systolic, the orifice is obstructed: diastolic, the valves are incompetent.

ii. Thrills felt in the second left intercostal space, or over the third left costal cartilage, close to the sternum: indicative of a lesion at the pulmonary orifice. Systolic, the orifice is obstructed: diastolic, the valves are incompetent. Here, however, it must be noted that, in aortic regurgitation, the heart may be displaced so much to the left, that a diastolic thrill, produced at the aortic orifice, shall be felt to the left of the sternum, in the second and third interspaces.

iii. Thrills felt at the apex-beat: indicative of a lesion at the mitral orifice. Systolic (not a mere quivering impulse, but a thorough thrill), the valves are incompetent: præsystolic (running up into the impulse, and brought to an end thereby), or diastolic (alternating with the impulse), the orifice is obstructed.

iv. Thrills felt over the fourth left costal cartilage, or in the fourth left interspace, close to the sternum: indicative of a lesion at the tri-

cuspid orifice. Præsystolic, the orifice is obstructed.[1]

v. Thrills felt in the fifth interspace and parasternal line on the right side: systolic: due to the sudden rush of blood into a distended right auricle.[2]

Concerning the explanation of the place and time of these many thrills, I may refer the reader to the chapter on Endocardial Murmurs: all that is said on these topics with regard to the murmurs, applies to the corresponding thrills. It may be well to remark that thrills felt to the right of the sternum are often due to aortic aneurysm.

Article III.—Pericardial Friction.

It is not at all uncommon to be able to feel the rubbing of pericardial exudations: a matter of small practical value. Friction is usually very unlike valvular thrill.

[1] Gairdner: Complicated cases of cardiac murmur: Edinb. Med. Journal: v. 871. Feb. 1860.

Haldane: Cases of disease of the tricuspid valve: Edinb. Med. Journal: x. 271. Sept. 1864.

An aortic aneurysm, which opens into the pulmonary artery, may cause a thrill in this place: see Wade's paper referred to in chap. v.

[2] Markham's case, before cited (p. 43).

Article IV.—Fluctuation.

In chronic copious pericardial effusions fluctuation may sometimes be felt, or even seen: an observation as old as Senac.[1]

SECTION III.

LARGE VESSELS.

The impulses and thrills produced in the large bloodvessels will be considered in the chapters on Thoracic Aneurysms.

[1] Traité de la structure du cœur, de son action, et de ses maladies. 2nd edit. vol. ii. p. 364. Paris, 1783. In Senac's patient, the fluctuation occurred during palpitations, in the third, fourth, and fifth interspaces.

Also Wintrich: Einleitung zur Darstellung der Krankheiten der Respirationsorgane. Virchow's Handbuch der spec. Path. und Ther. vol. v. part i. p. 65. 1854.

CHAPTER IV.

PERCUSSION.

SECTION I.

INTRODUCTORY.

Article I.—Historical.

PERCUSSION, or the art of striking a part of the body so as to beget a sound useful for the discovery of disease, has been practised from the earliest times. Employed at first in the diagnosis of abdominal diseases (to distinguish tympanites from ascites [1]), it was not until the middle of the last century that percussion was applied to the discrimination of the diseases of the chest. This important extension of the powers of percussion we owe to Auenbrugger, who in 1761 published a small book descriptive

[1] This most ancient means of diagnosis is probably at least as early as Hippocrates. During the three busy centuries after Hippocrates, the Greeks invented the word tympanites, which was in familiar use by the time of Celsus.

of his method.[1] He tells us that he was prepared to meet with envy, hatred, and calumny; we know that he found what is harder to bear, simple neglect: however the scanty records of the man's life justify the belief that he passed from one social deed to another social deed, and found his happiness in doing so.[2] It was worthy of Stoll that he at least should not fail to acknowledge the value of percussion;[3] but it was Corvisart who, guided by his favourite author, Stoll, may be said to have discovered Auenbrugger. For twenty years Corvisart practised percussion at the Charité of Paris, and finally, in 1808, he published a translation of the Inventum Novum.[4] Henceforth the importance of percussion was undisputed.

[1] Leopoldi Auenbrugger, M.D., Inventum novum ex percussione thoracis humani ut signo abstrusos interni pectoris morbos detegendi. Vindobonæ, 1761. This edition is very rare: a reprint was published at Graz in 1867. The second edition, of 1763, is more common. Translated by Forbes: Original cases, &c. London, 1824.

[2] Leopold Auenbrugger, der Erfinder der Percussion des Brustkorbes, und sein Inventum Novum: von Prof. Dr. Clar. Graz, 1867.

[3] Stoll: Rationis medendi pars tertia: p. 155: Viennae Austriae, 1780. Prælectiones in diversos morbos chronicos. vol. i. p. 86: Vindobonae, 1788.

[4] Nouvelle méthode pour reconnaître les maladies in-

The principles of the Inventum Novum are two: first that the sounds produced by percussion must be regarded simply as acoustic phænomena, and named accordingly; secondly, the sounds are to be explained by reference to corresponding physical states, that is to say, to the presence or absence of air in the part percussed.[1] Auenbrugger's doctrines remained unassailed until Piorry, in 1826,[2] sought to establish a new theory founded upon the principle that every organ yields to percussion a peculiar sound. Hence, a series of typical sounds: femoral, jecoral, cardial, pulmonal, intestinal, stomacal, osteal, humoral, and hydatid.[3] This scheme was afterwards discarded by its author, who proposed another in its stead: we will not forget that Piorry invented the pleximeter. In 1839, Skoda[4] published his theory, based

ternes de la poitrine, par la percussion de cette cavité, par Avenbrugger, ouvrage traduit du latin et commenté par J. N. Corvisart. Paris, 1808.

[1] Auenbrugger: §§ 17, 18, scholia.

[2] Paper read before the Parisian Academy of Medicine in that year.

[3] De la percussion médiate et des signes obtenus à l'aide de ce nouveau moyen d'exploration, dans les maladies des organes thoraciques et abdominaux. Paris, 1828. Page 33.

[4] Abhandlung über Perkussion und Auskultation. Wien, 1839. This work reached a sixth edition in 1864. A

upon two principles: "we must first determine every possible variety of percussion-sound, and ascertain the conditions on which each variety depends; and then endeavour to reconcile our observations with the well-ascertained laws of sound."[1] Wherefore, in the first place, Skoda restores Auenbrugger's principle of nomenclature, and distinguishes percussion-sounds according as they are full or leer, clear or dull, tympanitic or not tympanitic, high or low; epithets which will be explained hereafter. In the next place, Skoda developes Auenbrugger's second principle by maintaining that "the different sounds, which percussion produces over the regions of the liver, the spleen, the heart, the lungs, and the stomach, do not depend upon any peculiarities in these organs, but upon variations in the quantity, distribution, and tension of the air, present in the regions in which they lie, and upon the force of the percussion stroke."[2] The doctrines of Auenbrugger are in essence the doctrines of the present day.

translation of the fourth edition, by Dr. Markham, was published in 1853.

[1] Skoda: Markham's trans. p. 4.

[2] Skoda: Markham's trans. p. 6.

Article II.—Method of Percussion.

i. Immediate Percussion.—This was the method employed by Auenbrugger, and may be described in his own words: "Let the chest be percussed by the tips of the fingers drawn together side by side and stretched out straight; let the chest be covered by a vesture, or the hand by a glove (not of smooth leather), for if the naked chest be struck by the naked hand a smack ensues which hides the character of the sound we wish to produce." [1] Corvisart often percussed by the whole flat of the hand.[2] At the present day immediate percussion is performed only upon the clavicles (they constituting pleximeters), or when the physician wishes to obtain a rough preliminary notion of the resonance of a considerable extent of the chest surface.

ii. Mediate Percussion.—Auenbrugger's glove was obviously an approach to that mediate percussion which was first systematically practised by Piorry.[3] Piorry interposed a thin plate of

[1] Inventum novum, §§ 4, 5.
[2] Nouvelle méthode, p. 18.
[3] Percussion médiate, p. 14.

ivory (pleximeter) between the chest and the percussing fingers; the fingers moreover he kept half bent, so that percussion was made by their very tips, and not by their pulps, as in Auenbrugger's process. To substitute a hammer for the percussing fingers was no great stretch of inventive genius: Laennec frequently percussed with his massive stethoscope: from time to time divers plessors have been contrived, which may be seen in the shops of surgical instrument makers. But a hammer possesses no real advantage, and a finger of the left hand forms a perfect pleximeter: whence it comes that few physicians employ either plessor or pleximeter, except for the purpose of demonstration before a large class.[1] When the fingers are used to percuss with, it is necessary that the movement of the hand should proceed from the wrist and not from the elbow or shoulder, a

[1] Piorry. Traité de plessimétrisme et d'organographisme; anatomie des organes sains et malades, établie pendant la vie au moyen de la percussion médiate. Paris, 1866. Here the reader will find the argument stated in favour of the pleximeter. In the same book there is a description of divers plessigraphs.

Wintrich: Einleitung, p. 5. Here the cause of the hammer is pleaded.

nicety in manipulation which is acquired by practice.[1]

Article III. Theory of Percussion.

The first object of percussion is to discover what kind of sound is emitted by the part percussed. A secondary object is to discover the degree of resistence, or the density of the stricken spot.

¶ I. SOUND IN GENERAL.

All sounds own the common properties of loudness and duration: two other properties, namely, tone and pitch, are peculiar to some sounds only.[2]

[1] For the use of resonators and sensitive flames in the examination of the chest, see Gerhardt: Lehrbuch der Auscultation und Percussion, mit besonderer Berücksichtigung der Inspection, Betastung, und Messung der Brust und des Unterleibes zu diagnostischen Zwecken. 3rd edit. Tübingen, 1876: pp. 81, 116, 161, 272.

For tuning forks, see Wintrich: Einleitung: p. 44. And Baas: Phonometrische Untersuchungen der Brust und des Unterleibes. Deutsches Archiv für klinische Medicin, vol. xi. p. 9. 1872.

[2] Tyndall: Sound: a course of eight lectures delivered at the Royal Institution of Great Britain. London, 1867, p. 69.

i. Loudness and Duration.—The loudness of a sound depends upon the length of its constituent waves. The duration of a sound depends upon the number of its constituent waves; that is to say, upon the time during which wave follows wave so closely as to be indistinguishable from each other by the ear, and to constitute a single sound.

ii. Tone and Pitch.—Both these properties regard the sound-waves in their relation to each other; that is to say, in their succession. The tone of a sound depends upon the order with which the waves follow on, upon their rhythmical succession, upon their exact repetition at regular periods, and with sufficient rapidity; it being found by experiment that the number of waves must not be fewer than forty in a second, otherwise they do not blend into a tone. The pitch of a sound depends upon the swiftness with which the periodic waves follow each other, upon the number of rhythmical shocks which happen in a given space of time: the swifter the succession, the higher the pitch.

iii. Noise.—Sounds, which are wanting in tone, may, for the sake of distinction, be called Noises. Noises are of two kinds. They may consist of irregular successions of sound-waves,

lacking the conditions of rhythm and rapidity which are essential to tone. Or they may consist of a number of tones, simultaneously produced, which do not harmonize, and which the ear cannot resolve or separate into the constituent parts.

iv. Tone is the musical quality; and pitch depends upon it. For a sound which is not a tone, and which does not consist of the regular and rapid succession of waves, cannot afford that definite number of shocks, within a given time, which constitutes pitch. Or, again, a sound made up of an indistinguishable number of inharmonious tones cannot possess a distinguishable pitch. There is also a relation between pitch and duration which will now be understood; a tone, which consists of a certain number of sound-waves, is shorter in duration just as it is higher in pitch.

¶ II.—PERCUSSION-SOUNDS.

The first division of percussion-sounds depends on tone; its presence or its absence. Some sounds are tones and some are not; hence the main distinction. And also the most ancient distinction; whereof the appreciation was, as we have seen, the first step taken in the art

of percussion : the difference between a tone and a noise being the difference between the percussion-sound of a tympanitic and an ascitic belly.

CLASS I.—PERCUSSION-TONES.

Percussion-tones are also called clear sounds or resonances, for reasons which will appear hereafter. I shall consider these percussion-tones under the sundry headings of their four common properties just discussed, namely, their loudness, duration, pitch, and tone.

I. LOUDNESS.—Loudness is not a character of much practical worth, depending as it does, not only upon the conditions of the sonorous material, but also upon the force of the percussion-stroke.

II. DURATION.—Duration is a somewhat more important quality. The prime property assigned by Skoda[1] to a percussion-sound, its fulness or its leerness[2] (ideas adopted from Laennec[3]) is, in

[1] Markham's translation : p. 8.

[2] Skoda's word "leer" is translated by Markham "empty" : I formerly suggested "scanty." But, indeed, the word "leer" needs no translation, for it is English as well as German, and bears the same meaning in both tongues. I have often heard the word in country places. See Halliwell's Archaic Dictionary : Leer or Lear.

[3] Auscultation médiate : vol. i. p. 28.

fact, a compound perception, made up chiefly by the duration of the sound. The duration of a tone depends mainly upon the elasticity, the swaying power of the sounding body.

III. Pitch.—Pitch is a much more important quality. The many different degrees of pitch, distinguishable in percussion-tones, are reduced to three or four heads, which have received arbitrary names. So that we have a kind of scale of percussion-tones.

i. The lowest-pitched tones are called Tympanitic,[1] because they are usually yielded by a tympanitic belly.

ii. The somewhat more highly-pitched tones I have proposed to call Sub-tympanitic, thereby to keep up the traditions of Auenbrugger;[2] it is

[1] Skoda gives the word "tympanitic" wholly another meaning. So well as I can make out, tympanitic means, with him, the same thing as that which I call clearness of tone, or rather perfect clearness. A tone, which is muffled to any degree, is "not-tympanitic" with Skoda. Wintrich makes this complaint: "Ich muss offen gestehen, dass mir die Expositionen des Wiener Meisters über alle die genannten Schalldifferenzen ganz unklar geblieben sind, zumal wenn der Versuch gemacht wurde, sie mit den Gesetzen der Physik oder auch nur den praktischen Auffassungen der Musiker in Verbindung zu bringen." Einleitung, p. 39. French disciples of Skoda call his tympanitic note, le bruit skodique.

[2] Sonus, quem thorax edit, talis observatur, qualis in

the note usually yielded by healthy lungs, in their natural state of distension; the Pulmonal note of Piorry.

iii. The still more highly-pitched tones are called Tracheal[1] or Tubular, being more or less like the note yielded by the trachea, when the mouth is a little open.

iv. The highest-pitched tones are called Osteal,[2] because they are yielded by the hard solid tissues, cartilage and bone.

IV. Tone.—Thus far I have treated of percussion-tones as if they were highly gifted with that property; but such is not the case. Indeed, they are seldom pure or clear; their musical quality is mostly impaired; the tone is obscured, muffled, or dulled. And there are all degrees of tone-dulling down to utter dulness, or a noise wholly bereft of tone. Wherefore percussion-sounds are said to be more or less clear, more or less dull. And here I would affirm that

tympanis esse solet, dum panno vel alio tegmine ex lana crassiori facto, obtecta sunt. Inventum novum: § 2.

[1] C. J. B. Williams: Lectures on the physiology and diseases of the chest, including the principles of physical and general diagnosis. London Medical Gazette: vol. xxi. p. 918 (March 10, 1838), and vol. xxii. p. 8 (March 31, 1838).

[2] Piorry: Percussion médiate, p. 31.

these words, clearness and dulness, relating to the degree of purity of tone, are not only hallowed by long usage, but also possess a strict scientific meaning. We inherit them from Auenbrugger,[2] who, in a sentence of fourteen words, has summed up the acoustic phenomena of percussion. The sound is a tone, clear or muffled, even to complete privation; this is the first and great distinction. And next, the tone is of a pitch higher or lower. Upon these two hang the whole theory and practice of percussion.

CLASS II.—PERCUSSION-NOISES.

Concerning the noises of percussion, the sounds which are toneless or dull, there is but little further to say. They possess the qualities of loudness and duration; but these, in percussion, are lightly esteemed. Any other differences depend upon the degree of dulness, whether absolute or not; whether, in fact, some amount of tone is mingled with it or not.

[1] Tyndall: Sound, p. 51, for example.

[2] Sonitus vel altior, vel profundior; vel clarior, ve obscurior, vel quandoque prope suffocatus deprehenditur. Inventum novum; § 10, scholium. Curiously misunderstood by Corvisart: Nouvelle méthode, pp. 30, 31.

CLASS III.—BY-SOUNDS OF PERCUSSION.

Certain by-sounds, commonly called metallic, sometimes accompany the sounds which have been described. Metallic sounds are two: metallic ring and cracked pot.

I. THE METALLIC RING (empty bottle note, amphoric note) consists in an overtone[1] existing either apart and alone, or as a harmonic superadded to the fundamental tone, which itself may be either clear or muffled. Percussion of the stomach when distended with air will yield the metallic ring. Also fillipping the cheeks sharply, when they are blown out to a degree which may be learnt on trial.

II. THE CRACKED POT sound (metallic chink, cracked metal sound) was discovered by Laennec.[2] It is a sort of metallic ring, which may be likened to the chinking of money, or to the sound produced by clasping the hands loosely together, and striking the back of one of them upon the knee. Percussion of the chest of a healthy screaming baby will often give a cracked-pot sound. A heavy blow, expiration,[3] and the

[1] Tyndall: Sound, pp. 116 et seqq.

[2] Auscultation médiate: vol. i. pp. 100, 655.

[3] Cornil and Grancher. Comptes rendus des séances de la société de biologie: for 1873: series v. vol. v. p. 51.

mouth open, are mostly needful in bringing out the chink. Its causes are not always the same; they will be set forth hereafter.

¶ III.—PHYSICAL CONDITIONS OF PERCUSSION-SOUNDS.

The main qualities of sound, and their essential nature, have been discussed in foregoing pages.[1] We have now to pass from sound in idea to sounds in fact; we have to search out the ways in which sonorous waves become modified by the different conditions under which they take place. The conditions modifying sound, which meet us at the outset, and which we shall have continually to bear in mind as we go along, are two: Conduction and Reflection. But the topic becomes yet further defined; the only conditions which we have to examine are those which hold good in the human chest. In other words, we have to explain percussion-sounds in particular. And, inasmuch as the prime distinction between them lies in the presence or absence of tone, we will begin with the discussion of percussion-tones.

[1] Refer to ¶ 1: Sound in General.

I. PERCUSSION-TONES.—The only tones, with which percussion has to do, are those produced by the vibration of bone, cartilage, or stretched membrane.

The sound of percussed bone and cartilage (for instance, that yielded by percussing the shin with the tips of the fingers) partakes from the first of the nature of a tone.

But with stretched membrane the case is different. Percussed in open air, it yields no tone. Nor can it be made to do so, unless it vibrate over an air-containing cavity with smooth walls. Under these circumstances, the sound-waves, which the air conducts from the membrane, are stopped and reflected by the walls of the cavity. But reflection alone will not beget a tone, unless the reflection be rhythmical. And rhythmical reflection requires a certain fixed relation between the rate at which the membrane vibrates, and the length of the air-column beneath. Given these necessary conditions, then the vibrations of the membrane become rhythmically reinforced by reflection; and rhythmical vibration, if rapid enough, will yield a sound having all the characters before described as being proper to tone. The reinforce-

ments or production of tone by rhythmical reflection is called Resonance.[1]

In the case, then, of a membrane stretched over a cavity containing air, when we strike the membrane we produce a flutter of the air contained in the cavity; and some pulse of this flutter, corresponding to the size of the cavity, according to the law just laid down, is raised by resonance to the dignity of a tone.[2] And this is the reason why the words tone and resonance, as applied to percussion-sounds have come to mean the same thing; the only tones which percussion knows (those of bone and cartilage excepted) are produced by resonance.

The conditions at which we have now arrived are these: a sac containing air. Let us carry our analysis yet further, and begin by distinguishing between an air-containing sac wholly shut, and one partly open.

1stly. Sac completely closed. We will discuss, in order, the cavity containing air and the wall of the sac.

i. The Air-containing Cavity.—It must be large for it to yield a Tone. To speak with greater precision than this is unnecessary, and

[1] Tyndall: Sound, p. 172.
[2] Tyndall: Sound, p. 178.

indeed impossible, because the tone depends on many conditions other than the mere size of the cavity. The Pitch of the tone, so far as the cavity alone is concerned, is low in direct proportion to the length of the air-column.

ii. The Sac-Wall.—All the qualities of the sound produced—clearness, loudness, and pitch—depend more upon the sac-wall than upon the bulk of air contained therein. The sac-wall is indeed the sound-swayer,[1] determining what the sound shall be. Let us discuss the sound with regard, first, to its production, and next to its conduction.

a. The production of the sound.—*a*. i. Clearness of tone.—In order to yield tone, the sac-wall must be apt to vibrate rhythmically along with the contained air. In other words, a unison vibration, convibration, or consonance of the sac-wall is required to the production of tone. Mere reflection of the air-vibrations from the inner surface of the sac-wall is not enough; the production of resonance requires a consonance of the containing membrane, whereby to keep up the vibrations of the air. When we search into the conditions which favour or oppose the convi-

[1] Schallherrscher. Wintrich: Einleitung, p. 16.

bration of the sac-wall, we find that its elasticity is the chief of them. The tension of the wall is indeed a matter of some consequence; for the membrane must be flexible enough to vibrate rhythmically, and high tension opposes flexibility: a fact which may be demonstrated upon the cheeks, and which is often demonstrated for us by the membrana tympani,—a certain mean tension being needful to good vibration. But the elasticity of the sac-wall is a much more important condition than is the tension; loose and inelastic membrane cannot vibrate rhythmically. In sum: the sac-walls must be flexible and vibratile enough for the column of air within to be able to bend them to its own vibration, and thereby to make them its own sounding-board and tuning-fork;[1] else a clear-toned resonance is impossible. When the sac-wall consonates imperfectly the tone is proportionally muffled; and of muffling there are all degrees up to absolute dulness. *a.* ii. Pitch. — Acoustics teach us that the pitch of the tone of a vibrating membrane varies with its tension, thickness, density, and the like. We find, in practice, that an air-containing sac often yields

[1] Tyndall: Sound, p. 175.

to percussion a high-pitched tone, which is not the fundamental or ground tone of the cavity; but which is probably an overtone or harmonic of the actual or potential ground tone. Such seems to me to be the nature of the metallic or amphoric ring already described. The lower-pitched ground tone is often badly produced; it has not force enough to make the membrane vibrate rhythmically. To do this, greater force is necessary, and greater force means quicker vibration,[1] and quicker vibration means higher pitch. That is to say, the overtone can cause the sac-wall to consonate, when the ground tone cannot.

β. The conduction of the sound.—Loudness. Suppose that the unison-vibration of air and membrane has produced a tone, it has yet to be conducted to the outer air. And this transference from membrane to air causes a great loss in the loudness of the tone. Wherefore, when possible, we put our ear upon the membrane itself, and thereby do away with the condition which interferes with good conduction.

To apply these doctrines to the percussion of the chest. Pneumothorax fulfils the conditions of a cavity, large, closed, and air-containing

[1] Tyndall: Sound, pp. 91, 179.

The reader will easily understand why a muffled low-pitched tone is yielded to percussion, and a clear, high-pitched metallic ring to percussion and auscultation combined.

2ndly. Sac partly open. The consequences of an opening in the sac-wall are chiefly three.

i. For the production of a percussion-tone, a much smaller cavity will suffice in the case of an open sac than in that of a closed sac. Wintrich found that a column of air, six lines in length, was the shortest which would yield to percussion a tone variable in pitch; provided the cavity be open at one end, and the ear be exactly over the opening.[1]

ii. The size of the opening modifies the pitch of the tone produced; the wider the opening the higher the pitch: a fact which may be demonstrated upon the mouth.

iii. Through the opening the tone is conducted without change.

To apply these doctrines to the percussion of the chest. The lung consists of a multitude of air-containing sacs and tubes. But the minute vesicular elements and the smallest bronchiola are, both singly and collectively, too small to

[1] Einleitung: p. 16.

resonate;[1] they are conducting structures and no more. The bronchia yield the pulmonary percussion-tone. And albeit they are open cavities, their openness has nothing to do with conduction of the tone: the tissues conduct it wholly. In proportion to the thickness of the conducting parts and their lack of elasticity, does the tone become muffled by conduction, even up to complete extinction or dulness: the loudness also is diminished: and the pitch is lowered, the sound-waves being slackened. These doctrines must be well understood; they alone make it possible to explain the physical conditions of the percussion-sounds of the lungs in health and in disease.

Take a healthy lung, distended as it is when within the chest. Percussion produces a clear tone in the bronchia; which tone, however, is not heard through the open tubes, but through the surrounding spongy structures. Now they conduct badly, when they are distended with air; partly because they consist of an incessant alter-

[1] Der tympanitischer Schall der Lunge kann nie als solcher in den Bläschen entstehen. Wintrich: Einleitung, p. 22. I quite understand that this doctrine may be disputed, and cannot be experimentally proved. Yet I do not see how we can set forth any theory of percussion, which does not assume that the spongy structure of the lung has nothing to do with the production of sound.

nation of membrane and air. Hence the percussion-note of naturally distended lung is not clear, but muffled. Remove the conditions of defective conduction; let the distension of the lung cease, and the air-sacs and bronchiola fall in upon the larger, stiffer tubes: in other words, let the lung relax, and become such as it is when taken out of the chest; percussion now will give a tolerably clear tone. For the layer of spongy structure around the bronchia has become thinner, and also probably more apt to consonate because less tense and more homogeneous; in short, a better conductor of the bronchial tones.

The conducting power of the minuter structures of the lung can be increased by other means than simple relaxation. Exudations, liquid or soft solid, partially replacing the air have this effect, and cause the lung to yield to percussion a clearer tone than natural.

A knowledge of these facts is so very important, be their explanation what it may, that the student should demonstrate them for himself upon the dead body (of a child, if possible). Let him percuss the chest and note the pitch and clearness of the resonance; then let him remove one lung, and percuss it when it has

become relaxed, and he will find that the note is very much clearer than before, although the pitch is higher. Upon the other side of the chest another instructive experiment may be performed. Let the chest be percussed; then let a small trocar and cannula be passed into the pleura, and air be injected through the cannula, but so as not to distend the side in the least. It will be found that the percussion sound is not much changed from what it was before the chest was opened. Now let air be injected so as to distend the pleura gradually to the utmost; and it will be observed that the percussion-note gradually gains in duration and clearness of resonance up to a certain point, and falls in pitch.

Before leaving this subject I may remark that our search into the physical conditions of percussion-tones has taught us that neither the clearness nor the pitch of the tone depends merely on the quantity of air in the part percussed. In other words, the theory of percussion is not so simple as many deem it to be.

II. PERCUSSION-NOISES. — Privation of the conditions, which have been declared necessary to the production and conduction of percussion-tones, results in percussion-tonelessness, noise,

or dulness. It will be readily understood that the privation may affect the loudness, the duration, or the tone of the sound, or any combination of these qualities. On the other hand, with regard to the physical conditions, there may be no tone-producing material in the part percussed, or the tone produced may be badly conducted, or the percussion-blow may be badly conducted. Applying these principles to explain percussion-dulness of lung, either the resonant parts are rendered less resonant, or the conducting parts less apt for conduction. The former is by far the more important condition: the larger air-tubes, which yield percussion-tone, no longer contain air. The first degree of solidification of the lung, that which involves the sacs and smallest tubes, gives a clear tracheal note; the second degree, which renders the larger bronchia likewise airless, affords dulness to percussion.

III. Metallic By-sounds.—The nature of the Metallic Ring has been already explained. I may add here that the following conditions also are believed to be necessary to the production of this by-sound, namely, that the cavity possess smooth curved walls, and that it be not less than two inches in diameter.[1]

[1] Six centimeters (nearly two inches and a half):

It remains to say a few words upon the Cracked-Pot sound. Its physical conditions seem not to be always the same. i. One kind, that which percussion produces in screaming children, is believed by Wintrich [1] to take place in the glottis, when the quick and hard blow suddenly sends compressed air between the vocal cords, whereby they are thrown into irregular vibrations. ii. In like manner the cracked-pot sound which heavy percussion, upon yielding chests, produces in healthy lungs during mere expiration, is probably glottidean. iii. Another kind is but a variety of the metallic ring, and is associated with it, being produced, in air-containing cavities not wholly closed, when percussion causes a sudden condensation of the air, and so jars the tone. The mouth of the cavity enables the pressure within and without to be quickly equalised. To shut the mouth and nose prevents the production of a cracked-pot sound, but the metallic ring remains.[2] iv. It is likely that the sudden rush of air, through the open-

Wintrich : Einleitung, p. 34. If the cavity communicate with a bronchus, the size may most likely be much less.

[1] Einleitung, p. 36.

[2] Walshe : A practical treatise on the diseases of the lungs, including the principles of physical diagnosis. 3rd edit. London, 1860, p. 80.

ing spoken of, is attended by a hiss which heightens the effect of the cracked-pot sound. v. A sound, practically indistinguishable from the cracked-pot sound, is that to which Piorry has given the name of "humoral,"[1] and which is said to be sometimes produced by percussion over cavities which contain both liquid and air. The sound in question is a sort of percussion-rale, due to splashing of the liquid in the cavity. A bladder, holding both air and water, if strongly percussed just below the surface of the water, yields a humoral sound.[2]

¶ IV.—PERCUSSION RESISTENCE.

The sense of resistence felt by the percussing fingers is greater or less in proportion to the greater or less compressibility of the part percussed. Hence solids and liquids are very resistent; air-containing parts much less so. It is by means of this sign that the person percussing learns more from his percussion than does a bystander. Corvisart first drew attention to this sign;[3] Piorry, working out the subject,

[1] Percussion médiate, p. 31.
[2] Wintrich: Einleitung, p. 38.
[3] Nouvelle méthode, p. 16.

at last almost came to exalt the tactile sensations of percussion above the acoustic. But, apart from all exaggeration, there is no doubt that by the sense of resistence we can distinguish between certain states which agree in yielding absolute dulness to percussion. The great resistence of a liquid effusion, and the change which we so often perceive on passing from the heart to the liver, are examples of this truth.

Percussion Thrill. A peculiar quivering sensation, called by Piorry the hydatid thrill,[1] is sometimes produced by percussion. The finger feels as if it were repelled several times in succession by a sort of elastic resistence or fluctuation. Most likely the only physical conditions needful to the production of this thrill are a sac tightly full of thin liquid. No doubt these conditions are fulfilled by most hydatid cysts; but Skoda has shown that even a stomach, filled with water and hung up, will yield a thrill to percussion.[2]

Superficial and Deep Percussion. Before I proceed to apply these principles to the practice of the percussion of the chest in health and

[1] Son hydatique : Percussion médiate, p. 32.

[2] Markham's translation, p. 22.

disease, it will be proper to say a few words upon what are called Superficial and Deep percussion. By progressively increasing the force of the blow from the gentlest tap to the hardest the patient can bear, we influence progressively deeper layers of the part percussed. For example: gentle percussion will elicit as clear a pulmonary note an inch or two below the right nipple as above the nipple; but hard, heavy percussion will produce a tone which is much less long and loud in the former than in the latter spot, the true explanation being this: not that deep percussion brings out hepatic dulness below the nipple, but that, while gentle percussion influences only a small depth of lung, which depth exists as well below the nipple as above it, deep percussion, influencing a much greater depth of lung, shows, by a marked difference in the length and loudness of the sounds, that the necessary thickness of lung does not exist over the liver but does exist above it.

In like manner the direction of the blow modifies the sound produced: different parts being influenced according as the blow is quite perpendicular to the surface, or oblique, or nearly horizontal. As a rule the blow should be struck quite perpendicularly.

SECTION II.

PERCUSSION OF THE CHEST IN HEALTH.

The pulmonary, cardiac, and mediastinal regions must be separately considered.

ARTICLE I.—THE PULMONARY REGION.

¶ 1.—PULMONARY RESONANCE AND RESISTENCE.

i. TYPICAL.—Frequent experiment upon the healthy chest is the means by which to fix in the mind an idea of the sound and resistence afforded by percussion of the pulmonary regions. When disease affects one side only we possess in the other side a standard of health to which we may refer; even when both lungs are affected, but one more than the other, comparison is still useful: wherefore, to contrast the same parts of the two sides of the chest becomes an important rule in the practice of percussion.

ii. SUB-TYPICAL.—But certain deviations from the type are compatible with a state of perfect health; deviations for the most part due to the thoracic walls. The sound produced by percussion over the sternum, clavicles, ribs, and scapular spines, partakes of the osteal character. Ossification of the cartilages produces the same

effect. The greater the quantity of soft tissue, muscular or adipose, which covers the thorax, the greater the muffling of the sub-tympanitic resonance. Hence the percussion-note of the chest is clearer in front and at the sides than behind, clearer in thin persons than in fat; it is sometimes almost impossible to get any sound deserving the name of resonant by percussing the backs of fat flabby people. When the chest-walls are yielding, heavy percussion of the front of the chest will produce the cracked-pot sound. Wintrich [1] has shown that, during the long deep expiration which attends coughing or screaming, the chests of children become very much less resonant than natural; a fact which it is most important to remember. Any part of the chest-walls which is stiffly arched bears off the force of the percussion-blow from the underlying organs, and thus weakens more or less the impulse which we wish to impart to them.

¶ II.—EXTENT OF PULMONARY REGION.

The region which yields a pulmonary note extends from the very apex of the thorax on each side, as low as the sixth rib in front, the

[1] Einleitung, pp. 30, 56.

seventh at the sides, and the tenth or eleventh behind. But sundry viscera encroach upon these limits.

(i.) The Heart causes a certain extent of non-resonance in the anterior part of the chest; see next page. (ii.) The Liver can, by hard percussion, be detected on the right side as high as the fifth or even the fourth intercostal space in front, and ninth or tenth rib behind. (iii.) The Spleen on the left half of the chest, below the sixth rib laterally, modifies the percussion sound. (iv.) The Stomach, especially when distended with gas, affords its own resonance to percussion of the lower part of the left side of the thorax, as high, it may be, as the fourth rib, in the lateral region.

Article II.—The Cardiac Region.

The extent of cardiac percussion dulness will differ according to the force used in percussion, whether slight or great. Gentle percussion detects dulness only where the heart is uncovered by lung; this is the area of superficial dulness. Stronger percussion detects the dulness of the heart where it lies behind the lung; this is the area of deep dulness. The difference depends,

as before explained, upon the mass of lung influenced by percussion.

i. The Superficial area is roughly triangular in shape, the right side of the triangle being the midsternal line from the level of the fourth chondrosternal articulation downwards, the hypotenuse being a line drawn from the same articulation to a point immediately above the apex-beat, the base being a line drawn from immediately below the apex-beat to the point of meeting between the upper limit of liver dulness and the midsternal line. The area of superficial dulness is much diminished by a deep inspiration, much increased by the patient lying upon the left side (the same position which displaces the impulse to the left), and not materially affected by the patient lying upon the right side.

ii. The Deep-seated area reaches upwards as high as the third rib (in children even as high as the second interspace); to the left about a finger's breadth to the left of the impulse; and to the right as far as a little beyond the right margin of the sternum. But, in truth, the right limit of cardiac dulness is not very trustworthy, the osteal and conducted pulmonary notes interfering much with the cardiac percussion-sound.

No doubt it is sometimes quite easy to be able to discover the lower margin of the heart by percussion: sometimes a heightening of pitch and increase of resistence are tolerably well marked on passing from the heart to the liver; sometimes there is a distinct band of faint resonance between the two organs; and sometimes, in passing from the hepatic to the cardiac region, one becomes sensible of a slight increase in the intensity of dulness, and a most distinct increase in resistence, owing probably to comparative thinness of the left lobe of the liver, and its position over the stomach. When the heart and liver dulnesses pass indistinguishably into each other, we must be content with assuming the lower margin of the heart to correspond with a line drawn from a little below the apex-beat of the heart to the point of meeting between the right limit of cardiac dulness and the upper limit of hepatic dulness, bearing in mind how intimate is the connection between the heart and liver by means of the vena cava.

Article III.—The Mediastinal Region.

The contents of the mediastinum in the

healthy state do not affect the percussion-note in any way.

SECTION III.

PERCUSSION OF THE CHEST IN DISEASE.

Article I.—The Pulmonary Region.

Auenbrugger's Dictum.—If, over the fore-described pulmonary region, there is not perceived the fore-described pulmonary sound, equal on both sides, the force of percussion being equal, we may predicate the existence of disease where the sound is unnatural.[1] This is Auenbrugger's dictum, and comprises the whole theory of percussion.

¶ I.—PULMONARY PERCUSSION-SOUND.

The typical pulmonary-note may be departed from by increase or by diminution of its resonance. Hence two classes of unnatural sounds.

In the following pages it is assumed that the chest-walls are elastic and not too fat: in practice

[1] "Si igitur ex prædictis locis sonoris non percipitur sonus manifestus, utrique lateri æqualis, eidem percussionis intensitati conformis, morbosum quid in pectore latere significat." Inventum Novum. § 11.

it must ever be borne in mind that the more the rigidity and fatness of the chest-walls are increased the more is the percussion resonance diminished.

Class I.—Increased Resonances.

The resonance is increased by the tone becoming tympanitic or clear.

1stly. Tympanitic Resonance, mostly muffled, seldom or never clear, occurs when the sonorous column of air is greater than natural, a condition present in pneumothorax, and in some states of lung not easily specified.

2ndly. Clear resonance, sub-tympanitic or tracheal, occurs when the conditions which muffle the pulmonary sound are removed, provided that no new causes of tone-dulling are introduced. In other words, whatever relaxes the vesicular structure unmuffles the pulmonary tone and makes it clear; whatever replaces the vesicular structure by cavity containing air, but not tightly distended thereby; and lastly, whatever enables the clear tones of the larger air-tubes to be conducted to the surface.

i. Relaxed lung, when in contact with the chest-wall, affords at that spot a clear sub-tym-

panitic or tracheal tone. *a.* The lung is relaxed as a whole by pleural effusions, and by tumours or enlarged organs without the lung. But, inasmuch as the relaxed lung under these circumstances cannot keep up its contact with the whole of its chest-wall, the extent of the clear percussion-note is small. *β.* The lung is relaxed in part around sharply-defined pulmonary consolidations. *γ.* The lung is relaxed interstitially by solid or liquid intimately mingled with air-containing tissue. Hence the clear tracheal tones sometimes yielded by catarrh, œdema, congestion of the lung, pneumonia at its very outset or during resolution, phthisis and tubercle.

ii. Cavities, filled wholly or mainly with air, when at the surface of the lung, or, if deeply-seated, separated from the surface by dense solid tissue, may afford a clear sub-tympanitic or tracheal tone. Cavities surrounded by natural lung tissue do not much influence the percussion-sound. Sometimes the clear tone of a cavity is heard during expiration only; during inspiration, and still more when the breath is held, the tone becomes muffled.[1] The pitch of a clear tone rises or falls, according as the mouth

[1] Wintrich: Einleitung, p. 31.

is open or shut, when the cavity communicates freely with the air-tubes, for reasons before explained.

iii. Solid masses, coming to the surface, and closely connected with large air-tubes, sometimes yield a clear tracheal tone: pneumonia and pulmonary tumours may exemplify this fact. In this case also, the pitch varies with the state of the mouth.

Class II.—Diminished Resonances.

The resonance is diminished when the note becomes weaker and shorter, or more muffled. When absolute tonelessness is present, it is vain to draw (so far as the sound is concerned) any further distinctions. When a certain amount of tone is preserved, it is not only possible but useful to distinguish the degree of clearness and the height of pitch.

The following conditions are attended by diminution of pulmonary resonance:—

i. Extreme distension of the lung with air, for reasons before given. Hence we should never percuss a chest whilst the patient is coughing or holding his breath.

ii. Liquid and solid exudations into the lung

which do more than relax it; which, indeed, involve the larger air-tubes, and so destroy the conditions of resonance. Catarrh, œdema, congestion, pneumonia, induration, phthisis, often illustrate this fact; hæmorrhagic infarctus, cancerous and other tumours more seldom.

iii. Collapse of the lung.

iv. Liquid exudations into the pleura, whereby the lung is condensed to a degree beyond relaxation, and moreover separated from the chest-wall. But liquid is a good conductor of sound. Were resonant material behind the effusion, percussion would bring forth tone. The dulness shows that there is no resonant material behind the effusion; in other words, that the lung is deprived of air. That the dulness of a pleural effusion greatly depends upon the state of the underlying lung is proved by facts such as follow. α. A considerable pleural effusion may co-exist with a percussion-sound muffled in tone but far from absolutely dull. β. When patients who are put under the influence of chloroform with a view to paracentesis, struggle and scream, or simply breathe deeply, parts which before were wholly dull to percussion become resonant; yet, puncture these parts, and liquid freely flows. γ. When pleural effusion has been removed by

absorption or drainage, the dulness sometimes continues to be almost or quite as great as ever, the lung remaining unexpanded. Dense false membranes have the same effect.

Class III.—Metallic By-sounds.

I. The Metallic Ring is almost always present in pneumothorax, whether occupying the whole pleural sac, or loculated. Very large pulmonary cavities containing air may likewise afford this sign.

II. The sundry causes of the Cracked-Pot sound have been already set forth.

¶ II.—Pulmonary Percussion Resistence.

Whatever diminishes the elasticity of the part percussed increases the sense of resistence to percussion. Wherefore massive consolidation of the lung, liquid pleural effusions, and extreme distension of lung or pleura with air, afford a feeling of resistence more or less increased.

¶ III.—Extent of Pulmonary Region.

Over the cardiac region, percussion is employed in order that we may learn whether the

lung has shrunken away from the heart, or covers it, or whether the pleura contains air. In the diagnosis of adherent pleura, of phthisis, or of emphysema of the left lung, these signs become useful.

The discovery of the position of the diaphragm and mediastinum, and of contraction of the pulmonary apices, depends chiefly upon percussion. These subjects will be discussed hereafter.

Article II.—The Cardiac Region.

I have just shown how diseases of the lungs and of the pleuræ influence the area of cardiac dulness; I will now proceed to the effects of disease of the heart itself. The area of dulness (superficial and deep) may be diminished or increased.

i. Area diminished.—This occurs in the very uncommon cases of pneumopericardium, clear resonance superseding the natural dulness: a cracked-pot sound (humoral perhaps) has even been heard in such cases. Atrophy of the heart does not much affect the area of dulness.

ii. Area increased.—This occurs in enlargement of the heart, and in pericardial effusion:

for the diagnosis between these conditions the reader is referred to the second part.

Moreover, the area of dulness may be altogether displaced, in consequence of displacement of the heart; a subject considered in the chapter upon inspection.

Article III.—The Mediastina.

Dilatation of the large vessels, aneurysms, and solid tumours in the mediastinum are sometimes the cause of more or less dulness to percussion where there should be resonance; as will be further shown in the second part.

CHAPTER V.

AUSCULTATION.

SECTION I.

INTRODUCTORY.

Article I.—Historical.

AUSCULTATION existed not before Laennec. True, a few passages are found in the writings of earlier physicians[1] which speak of

[1] The following are the chief notices of auscultation contained in authors older than Laennec :—

i. Rales. Hippocrates, Prognostics, § 14. Caelius Aurelianus, Acut. Morb. lib. ii. cap. 14.

ii. Leather sound of pleural friction, and sound of lung shock. Hippoc. de Morbis : ii. § 59 ; ibid. iii. § 7.

iii. Friction-rale? Hippoc. de Morbis : ii. § 61. See Van Swieten : Comment. in Aphor. 1219.

iv. Succussion-splash. Hippoc. de Morbis : i. §§ 6, 15 ; ii. § 47 ; iii. § 16. De Intern. Affect. § 23. Coacæ Prænot. 424. De Locis in Homine : § 14.

v. Heart's sounds. Harvey : de Motu cordis et sanguinis, cap. v. : 1628.

vi. Pneumonic crepitation. Van Swieten : Comment. in Aphor. 826 : 1745. Quarin : Methodus medend. inflamm. Vindob. 1774, p. 101.

vii. Respiration bruissante. Double : Séméïologie générale, vol. ii. p. 31 : 1817. See an amusing tale of Double's

sounds heard in the chest, but the observations remained mere curiosities, wholly without influence upon practical medicine. It is interesting to mark the dawning of the great discovery. Corvisart had studied the different forms of enlargement of the heart, and had endeavoured to distinguish between active and passive enlargement; to this end the character of the impulse was carefully observed. Bayle, a disciple of Corvisart, was in the habit of applying to the heart-region his ear rather than his hand,[1] inasmuch as a heaving impulse is more readily detected thereby, be the reason what it may. Laennec, Bayle's friend and fellow-student, adopted the same method. Laennec had undergone a fifteen years' training in the hospitals of Paris when, in 1816, he was consulted "by a young person who presented the general symptoms of disease of the heart, and in whom pal-

claim to the discovery of auscultation, in Lond. Med. Gaz. vol. xi. : p. 189.

viii. Sounds of foetal heart. Mayor : quoted by Laennec, ii. p. 459.

I refer to Littré's edition of Hippocrates.

[1] "I have found this method nowhere alluded to, and Bayle was the first whom I saw employ it, when we followed the practice of Corvisart together. The professor himself never put his head to the chest." Auscultation médiate, 2me édit., vol. i. p. 5.

pation and percussion gave no information, on account of the patient's fatness. Her age and sex forbade an examination of the kind just mentioned (by putting the head to the chest), when I remembered a well-known acoustic fact, that if the ear be applied to one end of a plank, it is easy to hear a pin's scratching at the other.[1] I conceived the possibility of employing this property of matter in the present case. I took a quire of paper, I rolled it very tight, and applied one end of the roll to the præcordial region ; then leaning my ear on the other end, I was surprised and pleased to hear the beating of the heart much more clearly than if I had applied my ear directly to the chest."[2] He had discovered auscultation. At the Hôpital Necker he explored the new world gained for science ; and in 1818 he read a "Memoir upon Auscultation by divers acoustic instruments employed as means of investigation in the diseases of the thoracic viscera, and especially in pulmonary Phthisis."

In 1819 he published the first edition of his

[1] This remark would seem to imply that Laennec had put his head to the chest, in order "to hear the beating" of the heart : a phrase which he constantly uses : compare Auscultation médiate : vol. ii. pp. 385 sqq.

[2] Auscultation médiate : vol. i. p. 7.

book on Mediate Auscultation;[1] and, in 1826, the second.

Article II.—Methods of Auscultation.

It was by means of an instrument that Laennec was enabled to discover the powers of Auscultation. Since his day the stethoscope has been discarded by many persons, who, preferring immediate to mediate auscultation, apply the ear directly to the chest. And doubtless the sounds are heard loudest in this way; they are weakened by conduction through a stethoscope. However, the drawbacks to immediate auscultation are great, and chiefly these: the impossibility of listening to every patient's chest without the interposition of some kind of vestment, which, besides being a bad conductor of sound, gives rise to divers noises of its own; the impossibility of applying the ear to every portion of the chest; the impossibility of localising sounds with sufficient accuracy. Moreover, we must not take for granted that the ear, applied

[1] De l'Auscultation médiate ou traité du diagnostic des maladies des poumons et du cœur, fondé principalement sur ce nouveau moyen d'exploration. Paris, 1819. For title of second edition, see p. 54.

directly to the chest, will needs conduct the sounds more truly than will a stethoscope. Heart-sounds and murmurs, in particular, often acquire by immediate auscultation, a booming, indistinct character, which does not belong to them. When this is the case, what we lose in mere loudness by using the stethoscope is well repaid by the greater definiteness of what we hear. No doubt a person may become a skilful auscultator who listens with his unassisted ear; but let mediate auscultation ever be considered the rule of practice, and immediate the exception; the physician making of the stethoscope, not a crutch, but a staff, which he uses when he has it, yet when he has it not he does not want it.

Stethoscopes are solid (rods) or tubular (pipes); tubular stethoscopes are rigid or flexible; flexible stethoscopes are single or binaural; so that there are four kinds of stethoscopes in use. Solid stethoscopes are made of wood; rigid tubular stethoscopes of wood, gun-metal or vulcanite; flexible stethoscopes of caoutchouc. A flexible stethoscope conducts wholly by the column of air contained within the tube; when the pipe is plugged or pinched, it conducts no longer. Scarcely need it be said that rigid pipes conduct partly by the bore and

partly by the tube; and that solid rods conduct wholly by the solid.

The binaural, as compared with the single stethoscope, has certain advantages; chief among which is this, that sounds are heard louder with both ears than with one. But binaural stethoscopes are flexible, and the flexible stethoscope has this great disadvantage, that it conducts wholly by its column of air. Within all tubular stethoscopes resonance takes place; and the sounds, not being simply conducted, but also reverberated, are altered in character accordingly; especially do they thereby acquire a booming quality (tone in fact) which often belongs not originally to them. Wherefore, comparing tubular with solid stethoscopes, we may say that a solid rod conducts more truly (in respect of the special quality of the sound) than a pipe; and thus the advantage would be on the side of a solid stethoscope, were it not that the sounds conducted thereby, lose much in loudness. A rigid tubular stethoscope combines the advantages of rod and pipe; and this is the kind of stethoscope which experience has universally preferred from the days of Laennec downwards. To sum up: a binaural flexible stethoscope conducts all sounds more loudly, but many sounds

less truly; a solid stethoscope conducts all sounds less loudly, but many sounds more truly; a rigid tubular stethoscope stands as it were midway. A flexible stethoscope is chiefly serviceable when we have to auscult bedridden patients who cannot well be raised. But this is its only use: and it is needful to say that the following pages relate to auscultation with a rigid stethoscope, tubular or solid.

The microphone has hitherto been found of no avail in auscultation.[1]

Article III.—Murmurs in General.

A murmur is a sound produced by the flow of fluid, liquid or gaseous, along a tube. Fluid flowing, however swiftly, along a tube of equal caliber throughout, produces no sound. The condition necessary to the production of an onward murmur is a sudden change in the caliber of the tube.

I. Onward Murmur.—A jet of fluid flowing, swiftly enough, out of a narrow orifice into a wider space, is called a fluid vein.[2] The mole-

[1] Boudet de Pâris: Des applications du téléphone et du microphone à la physiologie et à la clinique. Paris, 1880.

[2] Félix Savart: Mémoire sur la constitution des veines

cules of a fluid vein are agitated by movements which cause the vein to vibrate, and which are productive of sound. The loudness of the sound depends upon the swiftness of the flow: the quality of the fluid, and the size of the orifice are of import only inasmuch as they exert an influence upon the swiftness of the flow. The sound is carried farthest in the direction of the flow, hence the name onward murmur.[1]

II. Backward Murmur.—Fluid flowing, however swiftly, from a wider into a narrower space, produces no sound. But if the stream break, swiftly enough, upon a bevelled edge, like unto that of a whistle, the fluid becomes vibrating and sonorous. If the bevelled edge surround a considerable constriction within the tube, the sound is carried farthest in a direction against the flow of fluid: hence the name, backward murmur.[2]

III. Musical Murmurs.—Murmurs of either

liquides lancées par des orifices circulaires en mince paroi. Annales de chimie et de physique: 2nd series, vol. 53, p. 337. Paris, 1833.

[1] Chauveau: Études pratiques sur les murmures vasculaires ou bruits de souffle, et sur leur valeur séméïologique. Gazette médicale de Paris. 1858, pp. 247, et sqq.

[2] Bergeon: Des causes et du mécanisme du bruit de souffle, p. 25. Paris, 1868.

kind sometimes acquire the character of tone; these are called musical murmurs.

i. A musical murmur is usually due to the consonance of a solid, which plays the part of the reed or string in an instrument, and which is set in vibration by the sonorous fluid stream.

ii. A musical murmur is sometimes due to the vibration of the fluid vein alone; especially when the tube is curved so as to form a semicircle just beyond the constriction which causes the fluid vein.

SECTION II.

AUSCULTATION OF THE LUNGS AND PLEURÆ.

Auscultation of the surface of the chest is practised with reference to three kinds of sounds: i. the Voice, as it is heard over the thorax: ii. the sounds of Breathing: and iii. the sounds produced in the Pleura.

Article I.—Thoracic Vocal Sounds.

The voice, as it is heard by auscultation, is usually called the Vocal Resonance: a phrase which we inherit from Laennec, and which involves a theory not yet discussed. It is useful to study the vocal resonance before the respiratory sounds; inasmuch as the origin of the sound

is, in the former case, clear and indisputable, but, in the latter case, not so. Let us follow the historical order : the first fact which Laennec discovered by auscultation concerned the vocal resonance.

¶ I. THEORY OF VOCAL RESONANCE.

The prime distinction between the different kinds of vocal resonance lies in the degree of change (in respect of articulation) which the tone of the voice has undergone by the time it reaches the surface of the chest. Whence two classes of vocal resonances ; the muffled (or more changed), and the clear (or less changed). Clear vocal resonance, being usually heard over the large air-tubes, is also called bronchophony.

i. MUFFLED VOCAL RESONANCE.—The naked ear applied to the chest of a person who is speaking, perceives an indistinct humming or buzzing noise : the laryngeal tones have lost greatly in clearness, or articulateness. Their loudness also is much diminished : so that a weak voice is not heard at all.

ii. CLEAR VOCAL RESONANCE, OR BRONCHOPHONY.—What vocal resonances shall be deemed clear enough to form a class apart from the

muffled vocal resonances is an arbitrary arrangement. The line is drawn at that amount of clearness which the voice possesses when listened to in the upper part of the interscapular regions, in a certain proportion of perfectly healthy persons. In some people we hear nothing different from what we hear over the rest of the chest; but in some we hear a vocal resonance which is comparatively clear, that is to say, which approaches more nearly in character to the articulate sounds heard over the larynx or pharynx. Bronchophony then I define to include the clearest vocal resonance ever heard over the healthy chest, and all degrees of clearness greater than this. For disease sometimes affords thoracic vocal sounds which are far clearer than any heard in health; sounds which are not more muffled than those heard over the larynx. And, just as the least clear vocal resonance, which can be called bronchophonic, is that which is heard over the healthy bronchi; so does auscultation of the larynx afford a standard of the most clear vocal resonance. For it is seldom possible that the voice should be heard over the chest, in health or in disease, with greater loudness or clearness than over the larynx.

The clearness of vocal resonance is not de-

pendent upon its loudness ; the weakest sounds may be as strongly bronchophonic as the loudest ; indeed, the two characters of clearness and loudness are often opposed, so that the clearness of bronchophony is rendered indistinct by its loudness ; the ground-tone of the voice drowns the articulated over-tones. When this is the case, we must seek to set aside the element of loudness : a consideration which leads us on to the topic of

Whispered Bronchophony. Now whispering is articulation pure and simple.[1] And the bronchophony of whispering is often much more clear than that of the voice loud as usual. Sometimes bronchophony cannot be detected unless the patient whisper.

Pectoriloquy. The name given by Laennec to that physical sign which was the subject of his earliest publication relative to auscultation. Pectoriloquy having been the first-fruits of his discovery, no wonder that he always clung with affection to the name and sign. Laennec meant by pectoriloquy, a very clear vocal resonance having two characters ; first, the being conveyed,

[1] De même que la parole est la voix articulée, de même aussi le chuchotement est le souffle glottique expiratoire articulé. Beau : Traité (hereafter cited), p. 20.

as it were, along the bore of the stethoscope to the ear of the observer: next, the being heard over a very small space of the chest.[1] Loudness of the vocal resonance has nothing to do with pectoriloquy; a whisper may possess the two notes of apparent transmission and exact circumscription. But the distinction drawn by Laennec between pectoriloquy and bronchophony is unnecessary. Pectoriloquy is nothing but a very clear bronchophony. The desire of making pectoriloquy to be a sign pathognomonic of accidental cavity within the lung led Laennec to speak of perfect, imperfect, and doubtful pectoriloquy: now he himself confesses that he could not distinguish doubtful pectoriloquy from bronchophony. In short, he wavered in his own definition; a fact known to his pupils.[2] But we need not imitate Laennec in blurring the meaning of the word: pectoriloquy, sharply defined as above, is a useful term.

[1] La pectoriloquie est parfaite quand, par la transmission évidente de la voix à travers le stéthoscope, par l'exacte circonscription du phénomène et de ceux que la toux, le râle et la respiration donnent en même temps, on ne peut, en aucune manière, la confondre avec la bronchophonie. Auscultation médiate, vol. i. p. 66.

[2] Harrison. Some remarks on pectoriloquy. London Medical Gazette, vol. xix. p. 457 (Dec. 24, 1836).

Sniffing bronchophony. In some conditions of lung, bronchophony acquires a remarkable sniffing character.

Ægophony. Another and somewhat similar kind of bronchophony is that which Laennec called ægophony, in order to indicate its likeness to the bleating of a goat. Still closer is the comparison which he makes between ægophony and the voice of Punch. Bleating bronchophony, in particular, is much better heard by the naked ear than with the stethoscope. Laennec's idea of ægophony also was confused by his desire to make the sign pathognomonic of pleural effusion. His own pupils could not follow him.[1] Nor will we ; apart from a mistaken motive, we shall find ægophony to be a very definite physical sign, and also a very uncommon one.

Vocal resonances are mostly heard best by auscultation with the ear alone ; sometimes, indeed, the stethoscope altogether fails to conduct them. The same is true of auscultation of a pitchpipe's sounds.

The vocal resonance, though useful chiefly as a confirmation of the notions acquired by auscultation of the respiratory sound, sometimes ac-

[1] Piorry : Percussion médiate, p. 84.

quires an independent value. When a patient breathes so as to produce scarcely any sound, or breathes noisily, or otherwise unnaturally, then we call in the aid of the vocal resonance to remove our difficulties. A kind of artificial vocal resonance is produced by causing the patient to sound a pitch-pipe during auscultation.

¶ II.—PHYSICAL CONDITIONS OF VOCAL RESONANCE.

The vocal resonance has been defined to signify the voice as it is heard upon the surface of the chest. Wherefore two points demand examination: What is the voice? How does it reach the surface of the chest?

The larynx is a reed instrument which is capable of sounding a fundamental tone. In common speech, sundry minor or segmental tones, overtones, are produced along with the chief tone. The vocal chords may vary the pitch of the tone they produce, but no change in the quality (timbre, clangtint) of the sound can be effected in the larynx itself. That is to say, the larynx cannot articulate. The mouth, however, by varying its shape, can be made to resound to any of the laryngeal tones; and it is to

different admixtures of these tones occurring in the mouth, that articulation is due.[1]

The next consideration concerns the manner in which the voice reaches the surface of the chest. The sonorous undulations generated within the glottis and articulated above it, pass upwards and downwards; and just as the pharyngeal vault, the nasal fossæ, and the mouth play the part of an arched roof, so does the trachea that of a speaking-trumpet. The inner surface of the windpipe reflects the vocal vibrations which would otherwise diverge and confines them in the tube, so that the voice is carried in all its fulness down the windpipe; and would be heard at the bifurcation of the trachea, as well as in the mouth, were it not for two circumstances, namely, that the current of air is in a direction reverse to the propagation of the sound, and that the articulated tones have to pass through the narrow glottis. Hence two causes of change in the thoracic voice to begin with.

But the analogy of the speaking-trumpet ceases at the bifurcation of the trachea. Clear

[1] Tyndall: Sound, pp. 197 sqq. See a curious anticipation of this doctrine in Shaftesbury's Characteristicks: Soliloquy, part 3, sect. 1. First published in 1710.

vocal resonance is not heard, in healthy people, beyond the neighbourhood of the larger bronchi: natural bronchophony ceases there. We have now to consider the physical conditions of the lungs. First of all we must remember that they are kept in a state of permanent openness or distension which favours the conduction of sound along the air-columns within the tubes. But, on the other hand, the progressively increasing number of air-tubes renders the sound they conduct to any given spot progressively weaker: the voice is no longer confined within a single cylindrical tube, but is spread out and diffused by an enormous number of minute diverging tubes, having a total sectional area very much greater than that of the single tube whence they spring. Probably the diminishing rigidity of the walls of the bronchia diminishes their reflective power: probably the increasing surface of tissue exposed to the sonorous vibrations increases the conduction of those vibrations, by the tissues, away from the air-columns. Wherefore the voice, heard over the surface of the lungs, has lost both in clearness and loudness, is both weak and muffled.

But why is the bronchophony of the larger ubes not heard above the vesicular vocal reso-

nances? Because the pulmonary tissue in its naturally distended state, consisting of an incessant alternation of air and membranous walls, is a bad conductor of sound, whether as to loudness or to clearness of tone: and the bronchophony must pass straight through the lung. It is hardly necessary to prove that distended lung does conduct sound badly: percussion already has shown that it does so; and let a person who has any lingering doubts upon the point explain why the heart-sounds are so much weakened by passage through emphysematous lung, and why, in many people, bronchophony ceases to be heard the instant the stethoscope passes from off the trachea on to the pulmonary regions.

ACCIDENTAL BRONCHOPHONY AND PECTORILOQUY.—Accidental bronchophony is the name given by Laennec[1] to the bronchophony which is heard at a spot where nothing beyond muffled vocal resonance would be heard in a healthy chest. Accidental bronchophony is due to increased conducting or reflecting power in the lung tissues.

i. Increased Conduction.—We have learned that the vocal resonance, heard at the surface of the lung, is muffled in consequence of having to

[1] Auscultation médiate, vol. i. p. 65.

pass through a badly conducting material, namely, the air vesicles and bronchiola. Now the conducting power is increased by whatever increases the homogeneousness of the structure of the lung, or, in other words, by whatever makes the lung approach nearer to simple solid or to simple air. The former case only, that of solidification, will be discussed in this place : the latter case of aërifaction, is complicated by conditions of reflection. Solidification includes collapse of the lung, exudations into it, and new growths. Simple collapse brings the larger bronchia nearer to the surface, and so promotes bronchophony. Such is not the case in exudative consolidations, yet they also increase the lung's conducting power. The note of a pitch-pipe, sounded between the lips, is heard much more clearly over pneumonic lung than over healthy lung.[1] A solid nodule, close to a large bronchium on the one side, and reaching the surface of the lung, has been known to conduct (perhaps to magnify) the bronchial voice so well as to render it deserving of the name of pectoriloquy.[2] A

[1] In the case of the horse, healthy lung tissue is a very bad conductor of sound, hepatised lung tissue is a good conductor of sound : according to Bondet and Chauveau, in a paper hereafter cited, p. 131.

[2] Walshe: Diseases of lungs, p. 147.

coincident pleural effusion brings in a new element of heterogeneousness. The sonorous columns of air in the bronchia have to give up their vibrations to the condensed lung, which yields them in turn to the fluid contained in the pleural sac; from the fluid effusion they have to pass through the solid walls of the chest. Yet liquid is a good conductor of sound: over a serous pleural effusion I have heard accidental bronchophony so clear that I could distinguish any number the patient spoke. Nevertheless the bronchophony often becomes weakened and muffled. Moreover, it sometimes becomes changed in quality by passage through the pleural fluid, that is to say, it becomes ægophonic or amphoric, according as the fluid is liquid or aërial.

ii. Increased Reflection.—The voice is conveyed along and within the air tubes, by constant reflection of its sound-waves. In the spongy structures reflection ceases, so far as the human ear is concerned. But if they be replaced by a cavity, not beneath the bronchia in reflecting power, bronchophony will take the place of a muffled vocal resonance. If the cavity be large, and its inner surface apt for reflection, the bronchophony acquires a prolonged hollow and

reverberating character, which, when very well marked, goes towards making up the sign of Pectoriloquy, as before defined.

Accidental Bronchophony is oftentimes clearer than the natural bronchophony heard over the vertebra prominens, sometimes clearer than the tracheophony heard just above the sternum, very seldom clearer than the laryngophony heard over the larynx, never clearer than the voice from the mouth.

Sniffing Bronchophony. — Concerning the physical conditions which give bronchophony a sniffing character, I cannot say much. Perhaps they consist in an admixture of whiffing or tubular expiratory sound with the conducted voice.

Ægophony.—i. Laennec believed that the smaller bronchia, especially those with walls bereft of cartilage, become flattened by a pleural effusion, so as to behave like the reed of a bassoon or hautboy. Thus the bronchial tree becomes a sort of wind instrument terminated by a multitude of reeds in which the vocal resonance quivers.[1] ii. Wintrich believes that the ordinary nasal character in bronchophony is due to a strong vibration of the walls of bronchia so small

[1] Laennec: Auscultation médiate, vol. i. p. 79.

that it is accompanied by actual collision of their opposed internal surfaces.[1] The vibrating column of air, broken incessantly, yet too rapidly for the intervals to be distinguished by the ear, imparts a nasal sound. When the interruptions to the sound become sensible to the ear, they yield the bleating character. Ægophony, in short, is a higher degree of nasal bronchophony.[2] iii. Stone believes that it is not the pure laryngeal fundamental tone of the voice which affords ægophony, but only the articulated over-tones, whether whispered or spoken aloud. A layer of fluid in the pleura, while it stops the larger and coarser vibrations of the ground-tone, lets pass the finer and closer undulations of the high harmonics.[3]

To conclude: excepting a few uncommon cases of pectoriloquy, it seems that resonance (in the strict acoustic sense) has nothing to do with the production of vocal resonances in health or disease; that in fact the phrase, vocal resonance, can be continued in use only with the distinct understanding that the word resonance

[1] I rather lean to the opinion that the articulated voice acquires its nasal quality in the pharyngeal vault.

[2] Wintrich: Einleitung, pp. 119, 146 sqq.

[3] W. H. Stone: On ægophony; St. Thomas' Hospital Reports, new series, vol. ii. p. 187. 1871.

is employed in a sense quite peculiar to the nomenclature of auscultation.

¶ III.—VOCAL RESONANCE IN HEALTH.

The vocal resonance over the pulmonary regions is weak and muffled. Behind, opposite the trachea and the bifurcation of the bronchi (over the upper dorsal spines), bronchophony is heard in a certain proportion of healthy persons: a circumstance probably accounted for by the fact that only solids intervene between the windpipe and the surface of the body at the spot indicated. Under the clavicles, near the sternum, the vocal resonance (especially on the right side, and in women) is often bronchophonic: the right bronchus is larger and lies higher than the left. The voice is more sonorous in some persons than in others: it is, in women and children, oftentimes inaudible over a large portion of the chest.

¶ IV.—VOCAL RESONANCE IN DISEASE.

1. Increased Clearness of Resonance: Accidental Bronchophony.—i. Whatever increases the conducting power of the spongy structure of the lung increases the clearness of the vocal resonance. It has been already shown that the

conducting power of the lung is increased by whatever diminishes the heterogeneity of its structure. Diminution of the quantity of air contained in a part of the lung, diminution of the number of the alveolar septa; either of these changes will be attended by increased homogeneity. For these reasons it will be apparent why consolidation of the lung and cavity are the two chief causes of bronchophony. Consolidation of the lung includes simple collapse, hæmorrhagic infarctus, pneumonia, induration, phthisis, tubercle, and cancer. Cavities are due to phthisis, dilatation of the bronchi, gangrene, or great emphysema.

ii. Cavity, however, often introduces a new element into the case, namely, increased reflection. Whence the bronchophony becomes, not only well conducted, but also prolonged, and "reverbs a hollowness."

iii. Collapse of the lung, attended by bronchophony, will be extensive enough to include large open air-tubes. And this is seldom the case, unless the collapse be due to pleural effusion, liquid or aërial. So that the pulmonary vocal resonance, whether bronchophonic or not, becomes subject to conditions imposed upon it by the divers kinds of pleural effusion, a topic

discussed already. For instance, bronchophony sometimes becomes ægophonic, sometimes amphoric. Yet simple changes in the degree of loudness and clearness of the vocal resonance are more common, especially in the case of liquid effusion.

2. Diminished Clearness of Resonance is an unimportant sign, except it be known to have supervened upon resonance unnaturally clear. And, in such cases, the soniferous power of the bronchi is at fault, in consequence of collapse, or of obstruction by mucus, blood, or exudation.

3. Pectoriloquy was deemed by Laennec[1] to be the infallible sign of an accidental cavity within the lung; and no doubt this is true as a general rule, but it is a rule to which there are exceptions. Small superficial consolidations, closely connected with large bronchia, may increase the vocal resonance by true consonance, after the manner of a sounding board, so as to yield perfect pectoriloquy: yet this is seldom the case. Laennec was right in believing that a lesion, which causes pectoriloquy, lies at the surface of the lung.

Sniffing bronchophony is heard oftenest in lobar pneumonia; seldom in simple collapse.

[1] Auscultation médiate, vol. i. p. 66.

Ægophony was deemed by Laennec [1] to be the infallible sign of a thin layer of fluid in the pleural sac; and no doubt this is true as a general rule, but it is a rule to which there are exceptions. Landouzy [2] believes that false membranes on the pleura may cause perfect ægophony: yet this cannot be often the case.[3] On the whole, good bleating ægophony is an uncommon physical sign. The word is often abused by being given to mere bronchophony with a nasal twang.

Resonance of the Cough and Cry. In infants the thoracic resonance of the cry sometimes affords useful evidence of disease; for instance, the cry heard through hepatised lung is strongly bronchophonic. In like manner, the resonance of the cough sometimes acquires value when other signs are absent. Much of what has been said of the voice applies to the cough and cry.

Article II.—Respiratory Sounds.

¶ 1. Theory of respiratory sounds.

The fundamental division of respiratory

[1] Auscultation médiate, vol. i. p. 72.

[2] De la valeur de l'égophonie dans la pleurésie. Archives gén. de Médecine, 1861, vol. ii. p. 669.

[3] Auscultation médiate, vol. i. p. 81.

sounds is the same as that of vocal resonances. The respiratory sound, which is heard over the larger air-tubes, differs, by the possession of a certain quality, from that which is heard over the spongy structure of the lung. Wherefore the former is called Bronchial, and the latter Vesicular breathing.

i. Vesicular Breathing.—The ear, applied to the breathing chest, detects a sound which may be defined by the negative property of not possessing the bronchial quality. Wherever breathing lung is in contact with the chest-wall, there we hear this sound. Its inspiratory portion has a duration equal to that of the inspiratory movement; the expiratory portion follows after the shortest possible interval, has a duration only one-fourth or one-fifth of that of the inspiratory sound, and is much less loud than it.

The sound is loud in proportion to the rapidity and depth of the breathing. The louder the sound the greater becomes the relative duration of the expiratory portion; and for this reason; the expiration-sound being potentially equal in duration to the expiration-movement (although during the latter part of the movement the sound is inaudible by the sharpest ear), whatever quickens and deepens the expira-

tion-movement makes the whole sound louder, and the audible sound longer. Sometimes the tranquil breathing of adults is unattended by expiratory sound. Sometimes, especially in fat middle-aged women, the breath sound can be hardly heard at all. Loud vesicular breathing was called Puerile by Laennec.[1]

Sometimes the inspiratory sound, instead of being continuous, is divided into three or four distinct parts: occasionally the expiratory sound likewise is duplicate: this is called jerking breathing: a sign of no practical importance.[2]

Sometimes the chest is felt to heave with inspiration before any sound is heard: this has been called deferred inspiration.

Sometimes the expiratory movement is prolonged in consequence of obstruction to expiration; when this is the case, the sound is prolonged also.

ii. Bronchial Breathing.—Bronchial breathing, like bronchophony, is heard about the seventh cervical, and three or four upper dorsal vertebræ in a great number of healthy persons: especially in those who are thin, in women, and

[1] Auscultation médiate, vol. i. pp. 49 et sqq.

[2] Roger: De la valeur séméiotique de la respiration saccadée. L'Union médicale. Oct. 5, 1861.

in children.[1] Bronchial breathing is distinguished from vesicular breathing by the possession of a special quality of sound, which is best called hollow or reverberating.[2]

The loudness of bronchial breathing is an unimportant property : the special quality is as well marked in weak respiratory sounds as in the loudest ; nay, loudness of sound often proves an impediment to the detection of that quality which alone constitutes the note of bronchial breathing. The expiration is always audible, although usually less loud than the inspiration : yet expiration manifests the special quality more clearly than inspiration.[3]

[1] Laennec : Auscultation médiate, vol. i. pp. 55, 56.

Lippe : Die Grenzen des normalen Bronchialathmens. Deutsches Archiv für klinische Medicin, ix. p. 535, 1872.

[2] Laennec : Auscultation médiate, vol. i. p. 55. But as P. M. Latham says, "The sounds can only be learnt by the practice of listening to them. It is useless to describe them. They are simple perceptions of sense, which no words can make plainer than they are, when the ear has once become familiar with them. I must leave you to be your own self-instructors, and recommend you to be constantly practising auscultation for the purpose." Diseases of the Heart : Lecture I.

[3] The differences noted in this sentence exist in the pharynx, a fact easily discovered by auscultation just in front of the ear.

Bronchial breathing sometimes loses its peculiar quality by conduction through a stethoscope, even of the best make : and an instrument with a bore too large is especially likely to bring about this unfortunate result. In such a case, immediate auscultation with the naked ear must be practised.

Laennec[1] gave the name Cavernous to that kind of breathing which possesses the bronchial or hollow quality in a high degree.

Another kind of bronchial respiration, which has been named Tubular,[2] is characterised by a well-marked whiffing quality. Tubular breathing is most frequently heard over hepatised lung, and, when once heard, is not likely to be forgotten. It is closely allied to sniffing bronchophony.

By the name of souffle or puff, Laennec[3] designated a phænomenon analogous to pectoriloquy, and sometimes superadded to bronchial, cavernous, or tubular breathing. The air during inspiration seems to be drawn away from the ear of the observer, and during expiration to be puffed back again.

[1] Auscultation médiate, vol. i. p. 57.

[2] The word tubular was first used by Laennec, with respect to the cough. Auscultation médiate, vol. i. p. 90.

[3] Auscultation médiate, vol. i. pp. 58, 421, 423.

By the name of souffle voilé, or veiled puff, Laennec[1] designated a phænomenon which it has puzzled his successors to identify. It is a modification of the puff, he says, in which each vibration of voice, cough, or breathing seems to shake a sort of mobile veil placed between a lung cavity and the observer's ear. Skoda[2] believes that Laennec intended to represent the phænomenon which is observed when the respiratory murmur is indistinct at the commencement of inspiration, but suddenly becomes bronchial, and even bronchial blowing, as the inspiration advances. Skoda's veiled puff is not very uncommon.

¶ II.—PHYSICAL CONDITIONS OF RESPIRATORY SOUNDS.

The physical conditions of the vocal resonance, as already set forth, and those of the breathing sounds are very much alike. The main question, which we have now to treat, concerns the source of the breathing sounds; that is to say,

[1] Ibid. pp. 59, 213, 421, 423, 449.

[2] Markham's translation, p. 99. Seitz' metamorphosing breathing (Ueber ein neues Hohlengeräusch: Deutsches Archiv für klin. Med., vol. i. p. 292, 1866) seems to be a kind of veiled puff, in Skoda's sense.

the manner in which they are produced. I may as well at once declare that, for my own part, I hold to Beau's doctrine in this matter.[1] Let the reader call to mind the fact that whispered sounds (in other words, sounds produced by respiration in the inactive glottis) are audible all over the chest, and he will then be more ready to agree that it is at least possible, not to say probable, that the ordinary unwhispered respiratory sounds are produced in the same place. The lungs in the chest are distended: the tubes are all open, apt for conduction and reflection. The passage of the breath through the narrow glottis into wider spaces above and below, produces sonorous fluid veins inspiratory

[1] Beau: Recherches sur la cause des bruits respiratoires perçus au moyen de l'auscultation. Archives gén. de Méd. Aug. 1834. Also, Traité expérimental et clinique d'auscultation appliquée à l'étude des maladies du poumon et du cœur, Paris, 1856.

Bondet: Etude sur la respiration; recherches physiologiques sur le mécanisme des bruits respiratoires. Gazette hebdomadaire, Dec. 4 and 25, 1863.

Bergeon: Théorie des bruits physiologiques de la respiration, Paris, 1869.

Bondet and Chauveau: Contribution à l'étude du mécanisme des bruits respiratoires normaux et anormaux. Revue mensuelle de médecine et chirurgie, vol. i. p. 161. 1877. They believe that much of vesicular breathing is produced in the air-sacs.

and expiratory. This glottidean breathing murmur, modified by resonance in the pharyngeal vault above and the windpipe below, is conducted down the air tubes just as the loud or whispered voice is carried. All that has been said concerning the conduction and reflection of vocal resonance applies to the respiratory sounds.

It is convenient to look upon the glottis as the only source of the breath-sound. But, applying the general principles of murmur-production, as before laid down, to the air-passages, we must admit that the nose, mouth, throat, any unevenness of the windpipes, the bifurcation of the tubes, and the mouths of the air-sacs, may all be deemed possible causes of onward or backward murmurs.

Bronchial breathing is the glottidean sound as heard in the larger bronchia. Vesicular breathing loses the bronchial hollow quality in consequence of the badly conducting material (the spongy textures of the lung) through which the sounds have to pass. Puerile breathing implies louder sounds than usual produced in the glottis, and a very open state of lung. Cavernous breathing is bronchial breathing rendered more intense by the reverberation of a

cavity. Tubular breathing is hard to explain; we do not know how it acquires its peculiar whiffing character.[1] The puff merely shows that the seat of the bronchial breathing is near the surface. Skoda's veiled puff is most likely due to some obstruction in the tube, communicating with a cavity, being suddenly removed.

¶ III.—RESPIRATORY SOUNDS IN HEALTH.

The breath-sound is vesicular over the whole of the pulmonary regions: excepting that bronchial breathing is to be heard between the scapulæ in many persons; sometimes under the right clavicle also (especially in women); and sometimes, yet seldom, under the left. The loudness of the breathing sounds differs very much in different people. In children, the res-

[1] Perhaps the following hypothesis meets the case. When disease consolidates the air-vesicles and bronchiola proceeding from a larger air-tube, and so converts it into a cavity with unbroken walls, it becomes capable of resonance. A current of air, passing across the mouth of such a tube, produces a flutter there, and a certain pulse of this flutter is taken up by the resounding cavity, and raised into a definite sound. An effect concurrent with both inspiration and expiration. See Bloodgood: Amer. Journal of Med. Science, 1860.

piratory sound is loud or puerile; a fact to be explained by the frequency of their respiration, and by the thinness of their chest walls.

A crepitation due to collapse is sometimes heard, especially at the bases of the lungs, and at the beginning of an examination; a few deep breaths suffice for the removal of this rale, when it is not due to disease.

¶ IV.—RESPIRATORY SOUNDS IN DISEASE.

I. Weak respiration indicates weak production or conduction of the glottic murmur. Whatever obstructs the air passages within, whatever compresses them without, whatever interferes with the movements of the chest, will produce weak respiration; which, in other respects, may be vesicular or may be bronchial. That form of weak breathing which has been called deferred inspiration, occurs especially in emphysema and in laryngeal obstruction.

II. Loud respiration indicates good production and conduction of the glottic murmur. When local and a consequence of disease, the breathing is often obstructed in some part of the lungs other than that where the loud respiration is heard.

III. Bronchial respiration, heard where natur-

ally the breathing is vesicular, indicates obliteration of the damping spongy structure of the lung: obliteration which may be brought about in two ways :—

i. By collapse of the air-sacs, or by exudation into them, or by both processes combined. The pulmonary substance, thus rendered more homogeneous, is better fitted to convey the bronchial sounds to the surface. Pneumonic, phthisical, tubercular, hæmorrhagic, cancerous consolidations; collapse, simple, congestive, or œdematous; and thickening of the bronchial tubes with condensed surrounding tissue; all produce this effect.

ii. By destruction of the air-sacs: whereby the vesicular structure is replaced by large cavities capable of much reverberation. Phthisis, and dilatation of the bronchi, are the most frequent lesions belonging to this class.

Wherefore, in short, consolidations and cavities are the chief causes of bronchial breathing, as also of bronchophony.

iii. The case of consolidation, whether mere collapse or other, is sometimes complicated by a concurrent pleural effusion. Under these circumstances, somewhat depends upon the kind of the effusion, but more upon the state of

the lung. The sounds in the solid lung are either weak or bronchial, as before explained. A liquid effusion simply conducts the breath sounds, thereby weakening them more or less. An aërial effusion either simply weakens the sounds, or imparts to them an amphoric hum.

¶ V.—RALES.

The natural breath-sound having been described, and also the changes in that sound which are due to disease, I now come to Rales, or sounds which are produced within the lung by respiration, and which are wholly additional to the natural or morbid breath-sound. Rale, rhonchus, rattle; these words are synonymous. I shall retain the classification adopted by Laennec, and also his nomenclature, because I believe that his distinctions are of practical value in diagnosis, and that his names are as good as any others.

Rales are of three kinds: crepitant, mucous, and sonorosibilant.

I. Crepitant Rale. — A rale which has been well compared to the sound produced by rubbing a lock of the hair between the fingers

close to the ear.[1] Crepitation of this kind is heard during inspiration, sometimes throughout the whole of it, sometimes towards the end of it only: sometimes, but seldom, crepitation is expiratory also. Pneumonia, collapse, and œdema of the lung, are the three conditions which afford a crepitant rale. Its occurrence in collapsed lung, during a deep-drawn breath, affords, I believe, the key to the immediate physical condition necessary to the production of inspiratory crepitation in most cases; namely, the opening up of collapsed air-sacs.[2] Disseminated collapse of single air-vesicles is an important item in the changes consequent upon pneumonia and pulmonary œdema, as any one who will inflate the uncut engorged or œdematous lung of a child may easily discover. Insufflation of the lung in such cases will bring out an immense number of air-sacs, which were before invisible because collapsed, and which collapse again directly the air is allowed to escape: the transparent, non-pigmented tissues

[1] Williams: Lectures. London Med. Gazette, vol. xxi. p. 275 (Nov. 18, 1837); vol. xxii. p. 261 (May 12, 1838).

[2] Van Swieten: Comm. in Aphor. § 826. "Ingratus in pectore strepitus, qui fit a vesiculis pulmonum siccis hincque crepitantibus instar corii arefacti, dum inspirando extenduntur," vol. ii. p. 724. Lugd. Batav., 1745.

of a child are particularly favourable for this experiment. In pneumonia as soon as the hepatisation becomes dense the collapse cannot be removed by any pressure of air. Sometimes, doubtless, crepitation is a very fine mucous rale. Indeed, the main distinction of crepitant from mucous rale, so far as concerns the sounds alone, lies in the shortness or smallness of each crepitus, and, what is mostly associated herewith, the large number of crepitations attending each inspiration.[1]

II. Mucous Rale.—This rale includes all the sounds which are due to the passage of air through mucus or other liquids contained in the air passages. The notion received is certainly, for the most part, that of bubbles bursting; sometimes the sound is crackling rather than bubbling in character. The mucous rale is subdivided into varieties, according to the following considerations :—

i. The apparent size of the bubbles: so small as to approach the crepitant rale (subcrepitant), so large as to deserve the name of gurgling, and all intermediate sizes.

[1] After the example set by P. M. Latham and Watson, the term crepitation is still used by many, so as to include mucous rale.

ii. The clearness of the rale: the rale being sometimes more or less obscure,[1] on account of the weakness of the respiration; a deeper breath (when this is possible) bringing out a rale much more distinct.

iii. The reverberation of the rale: when this character is well marked, the rale is called cavernous.[2] Reverberating mucous rales indicate the same physical conditions as do reverberating (bronchial) breathing or voice.

III. Sonorous and Sibilant Rales.—These are rales which are more or less accurately described by such words as snoring, cooing, whistling, hissing; the low-pitched sounds being called sonorous (rhonchus), and the high-pitched, sibilant (sibilus). Sounds of this kind are due to local narrowing of the air-passages; most commonly by mucus, in which case a cough, which dislodges the mucus, removes the rale. Palpable vibration often concurs with these rales.

IV. Doubtful Rales.—The respiratory sound is sometimes attended by sounds not comprehended in any species of rale hitherto described, and doubtful both as to situation and signifi-

[1] Rale obscur: Laennec: Auscultation médiate, vol. i. p. 103.

[2] Laennec: Auscultation médiate, vol. i p. 99

cance. I allude particularly to two kinds of sounds. First: sundry Creaking sounds, not seldom heard at the apices of the lungs, and possibly due to creaking of pleural adhesions, but possibly also produced in the tissue of the lung itself.[1] Secondly; the Dry crepitant rale with great bubbles, as Laennec[2] named a sound resembling that produced by inflating a dried bladder, and due, he supposed, to distension of the enlarged air-sacs of emphysematous lung.

Article III.—Pleural Sounds.

The pleuræ in a state of health yield no sound.

In diseases of the pleura sundry sounds are met with, which may be arranged in two classes; friction sounds, and sounds produced in large cavities.

¶ I.—friction sounds.

Any unevenness of opposed pleural surfaces,

[1] Bruit ou râle de froissement pulmonaire. Fournet: Recherches cliniques sur l'auscultation des organes respiratoires, vol. i. p. 172. Paris, 1839.

[2] Auscultation médiate, vol. i. pp. 106, 308, 343.

Louis: Recherches sur l'emphysème des poumons. Mém. de la soc. méd. d'observn. de Paris, vol. i. p. 215. 1838.

or any exudation or morbid tissue between them, tends to make a friction sound accompany the respiratory movements.

The discovery of friction sounds has been the most important addition to the practice of auscultation of the lungs, as it was left us by Laennec.[1] Not that he was altogether ignorant of these sounds. In the spring of 1824, Honoré, who had succeeded Laennec at the Hôpital Necker, having observed a peculiar sound in the chest of a patient, sent him for that reason to Laennec; who heard what he called "up and down rubbing," and considered it to be due to interlobular emphysema.[2] The real meaning of pleural friction was first made out by Reynaud.[3] The diagnosis of a friction sound depends upon a consideration of the following particulars:—

1st. The Character of the sound. This is sometimes quite peculiar, and special to pleural friction; giving a distinct notion, either of rubbing in any degree, between the lightest

[1] I have elsewhere alluded to the fact that Hippocrates knew pleural friction-sounds.

[2] Auscultation médiate, vol. i. p. 115.

[3] Mémoire sur quelques faits et aperçus nouveaux, relatifs à l'auscultation de la poitrine. Journal hebdomadaire de médecine, vol. v. p. 563, Dec. 26, 1829.

grazing and the harshest scraping: or of creaking comparable to the creaking of leather.

2nd. The Position of the sound. A friction sound is commonly heard over a small part of one side of the chest; especially the lower half of the chest below the axilla, or about the angle of the scapula; here the movements of the pleural surfaces upon each other are probably the freest. It is rare to hear friction sound on both sides of the chest at the same time.

3rd. The Time of the sound. A friction sound may accompany inspiration, or expiration, or both, or only a small portion of either, especially the very end of inspiration. So that friction sound mostly attends the breathing movement; but occasionally pleural friction, over the cardiac region, attends the heart's movements only, so as to resemble pericardial friction.

4th. Friction sound is mostly an insulated phænomenon, that is, not accompanied by any unnatural quality of respiratory or vocal sound.

5th. Cough has no power of modifying or removing friction sounds.

The commonest cause of pleural friction is exuded lymph; organised false membranes, miliary tubercles, and mere extra-vascularity,

may likewise cause a friction sound. Laennec believed (as has been said) that a friction sound was producible by interlobular emphysema, and probably he was not mistaken. Walshe is of the same opinion,[1] and W. T. Gairdner in a case of vesicular emphysema without adhesions, heard a friction sound of "shuffling" character, and felt a distinct rubbing.[2]

Sound of Pulmonary Shock. Aran[3] has described, under this name, an excessively harsh friction sound, attended by palpable vibration, produced by cough, and due to the collision of lung and thoracic wall in certain cases of pleurisy complicated with pneumothorax.

¶ II.—AMPHORIC SOUNDS:

Or, sounds produced in a large cavity, are four in number: two spontaneous, and two produced by the physician during examination: the former are amphoric hum, and metallic tinkling; the latter are the bell sound, and succussion splash. I describe these signs in

[1] Diseases of the Lungs, p. 133. 1860.

[2] Clinical Medicine, p. 438. 1862.

[3] Sur un phénomène particulier et non encore décrit, produit par la toux dans l'hydropneumothorax. Arch. gén. de Méd., ser. v. vol. viii., Aug., 1856.

this place because they are most common in the pleural cavity.

I. Amphoric Hum.—By Amphoric hum[1] is meant a metallic resonance, such as is produced by blowing, speaking, or coughing, into a large and empty glass bottle. An amphoric hum requires the existence of a large cavity containing air; and may accompany—

i. The respiratory sounds; when there is a wide fistulous opening between a pneumothorax and a large bronchus, so that the breath flows freely in and out, an uncommon condition: or when loud bronchial respiratory sounds pass from unperforated lung through a large resounding cavity, and so acquire amphoric quality. A communication between the bronchi and the pneumothorax is certainly not necessary. The breath-sounds seldom become amphoric within a cavity of the lung itself.

ii. The voice, cough, and rales.

iii. The cardiac sounds heard through a pneumothorax, phthisical cavity, pneumopericardium, or stomach distended with air.

II. Metallic Tinkling.—A sound compared

[1] Laennec: Auscultation médiate, vol. i. p. 111. Bourdonnement amphorique.

by Laennec[1] to that which is produced in a metallic, glass, or porcelain cup when struck gently by a pin. Metallic tinkling is a single sound, which attends respiration, speaking, coughing, or even mere changes in the position of the body. With respiration the sound is mostly intermittent, that is, not heard with each movement; with speaking, the sound is produced more constantly, especially if the patient speak slowly, with a period between each syllable; with coughing, the sound is tolerably constant. The sound is heard on one side only, and is mostly heard best in the middle zone of the side; sometimes it is heard best at the apex, and is then of limited extent.

In pneumopericardium a friction sound will possess the characters of metallic tinkling.

III. Bell Sound or Metallic Ring.—This sign, well known to Laennec,[2] has been more particularly pointed out by Trousseau.[3] It is

[1] Auscultation médiate, vol. i. p. 109.

[2] En auscultant à l'aide du stéthoscope, et percutant en même temps, on entend une résonnance semblable à celle d'un tonneau vide, et mêlée par moment de tintement. Auscultation médiate, vol. i. p. 111. See Wintrich also; Einleitung, pp. 26 and 35.

[3] Pneumothorax; nouveau signe physique pathognomonique de cette affection. He calls the sound "bruit d'airain." Gaz. des hôpitaux, Apr. 4, 1857.

only the metallic ring of percussion, heard by auscultation, that is to say, by putting the ear to a large air-containing cavity, whilst an assistant strikes the surface of the sac by means of a metallic pleximeter and hammer, for which purpose two coins answer very well. Under these conditions a clear ringing sound will be heard, of a different loudness and duration in different cases, and sometimes not much inferior to the chime of a small clock.

IV. Splashing Sound.—This most venerable physical sign was well known to Hippocrates.[1] When a large cavity contains both liquid and air, and the patient is shaken while the physician applies his ear to the chest, a splashing sound is heard. In fact the splash is often heard by the patient himself.

V. Physical Conditions of Amphoric Sounds. —I have now spoken of the last of a most interesting series of signs afforded by large resounding cavities. I have classed these signs under the head of pleural sounds, because it is in the pleura that the necessary physical conditions are most often met with. These necessary physical conditions are the following :—

i. A Large Cavity.—The conditions of the

[1] See page 100.

metallic ring or bell sound have been already set forth in the chapter on percussion. The metallic tinkle may be heard, according to Kolisko,[1] in a cavity not larger than a pigeon's egg, provided that the cavity open into a large air-tube. The amphoric echo and the Hippocratic splash may occur in cavities of moderate size. The walls of the cavity must be smooth.

ii. The presence of Air in the Cavity.—The succussion splash requires the presence of liquid also. For the amphoric echo and bell sound, air alone suffices. Laennec thought that metallic tinkling did not occur unless both air and liquid were present in the cavity;[2] Skoda denies the necessity of liquid;[3] and no doubt he is right: the intensest amphoric echo of breathing sounds, or of rales; the falling of a drop of liquid; the bursting of a bubble; and crackling friction sounds, pleural or pericardial;[4] all are possible causes of metallic tinkle.

From the foregoing principles it will be now clear, why amphoric echo, metallic tinkle, and

[1] Skoda. Markham's translation, p. 135.
[2] Auscultation médiate, vol. i. p. 110.
[3] Markham's translation, p. 134.
[4] Beau: Auscultation, p. 192.

bell-sound occur in large phthisical cavities, and in pneumothorax: and why the splash may be produced in hydropneumothorax, in large phthisical, suppurative, and gangrenous cavities, and in hydropneumopericardium. Sometimes a distended stomach affords the means of demonstrating all the amphoric sounds: the colon will occasionally give succussion splash and bell sound.

Appendix to Section II.

There are sundry sounds which, although neither pulmonary nor pleural, depend upon the breathing movements.

1stly. Peritoneal Friction, produced between the liver and the diaphragm, may be heard all over the chest-walls on the right side.[1]

2ndly. Shoulder-Joint Friction; that is to say, a dry rubbing sound, mostly inspiratory, and heard in the supraspinous fossa, albeit produced in the shoulder-joint. The sound is heard louder as the ear is brought nearer to the joint, and is heard loudest over the joint itself. Some posi-

[1] Sibson: Medical Anatomy, column 44.

tions of the arm stop the sound; some movements produce it.[1]

3rdly. Shoulder-Blade Friction, palpable and audible, is sometimes, but seldom, due to friction of the scapula against the ribs, necrosed or not.[2]

4thly. Muscular Rumbling is often heard during auscultation, but, being continuous, cannot be confounded with pulmonary or pleural sounds.

SECTION III.

AUSCULTATION OF THE HEART.

Laennec brought auscultation of the lungs well nigh to perfection, but it was far otherwise with auscultation of the heart. He confirmed the truth of Harvey's remark, that sound is produced by the action of the heart:[3] he noted

[1] Gowers: British Medical Journal, Nov. 18, 1876.

[2] Duchenne: Electrisation localisée: 3me édit. p. 951. 1872. A case of atrophy of serratus magnus.

Galvagni: Ueber das Scapularkrachen: Medizinische Jahrbücher herausggbn von der k. k. Gesellsch. der Aerzte. Wien, 1873, p. 274.

[3] Ita dum istis cordis motibus fit portionis sanguinis e venis in arterias traductio, pulsum fieri et exaudiri in pectore contingit. Opera omnia a collegio medicorum Londinensi edita. De motu cordis, cap. v. p. 34. 1766.

that the sound is double: he discovered murmurs, or unnatural sounds: but when he assayed to go further, and to explain the sounds and the murmurs, he became lost in confusion; "seeking a way and straying from the way; not knowing how to find the open air but toiling desperately to find it out." He even went backward; specially by denying, in the second edition of his work, what he had maintained in the first, that at least some thrills and some murmurs are associated with valvular obstruction.[1] Our knowledge has greatly increased since the days of Laennec; but further historical details will be set forth in their proper places.

Article I.—Heart-Sounds in Health.

The ear, applied to the heart-region of a healthy person, will perceive that, for each impulse of the heart felt, two sounds are heard. One sound accompanies the impulse, one sound follows it: wherefore the former is called the first or systolic sound; the latter, the second or diastolic. The two sounds differ in character;

[1] Auscultation médiate, 2nd edit., vol. ii. p. 428. Compare 1st edit., vol. ii. p. 316. See P. M. Latham: Diseases of Heart: vol. i. p. 31. 1846.

the second being sharper and shorter than the first. The first sound is heard loudest over the fourth or fifth intercostal space, just within the left nipple line: the second, over the base of the heart, opposite the third costal cartilage.[1]

Concerning the loudness of the sounds:

i. Whatever weakens the heart weakens the sounds. And weakens the first sound especially: indeed, it sometimes becomes quite inaudible in patients suffering from great vital debility.

ii. But the loudness of the sounds, as we hear them, depends not only upon the state of the heart itself, but also upon the quantity of material interposed between the heart and ear. Wherefore in very fat people, in pulmonary emphysema, and in pericardial effusion, the sounds are weak.

Article II.—Heart-Sounds in Disease.

Sounds, heard over the heart-region, and morbid in character, are of two kinds: murmurs and pericardial sounds. The discovery of murmurs was made by Laennec:[2] that of pericar-

[1] For current doctrines respecting the causes of the heart-sounds, refer to text-books of physiology.

[2] Auscultation médiate, 1st edit. vol. ii. p. 214.

dial sounds seems to have been made by divers physicians about the same time; the earliest published reference to these sounds is found in a book written by Collin.[1]

¶ I.—MURMURS.

Any fundamental change in the character of a heart-sound, or any superadded sound heard over the heart region, constitutes a murmur: pericardial sounds excepted. So that it comes to this: we fix an idea in our mind of the healthy heart-sounds: and when we hear a sound over the heart which tallies not with the idea, we say, this sound is either a murmur or a pericardial sound. The diagnosis between these two kinds of morbid sound will be considered under the head of pericardial sounds.

The physical conditions of murmur have been already explained. In health, the respective sizes of the orifices and cavities of the heart are

[1] Des diverses méthodes d'exploration de la poitrine et de leur application au diagnostic de ses maladies, 1824. Pericardial sounds (called craquement de cuir neuf) are spoken of on pp. 64 and 115. Collin was Laennec's chef de clinique; but Laennec disbelieved in pericardial friction sound: Ausc. méd., 2nd edit. vol. ii. p. 446, 1826. P. M. Latham discovered this sign at St. Bartholomew's Hospital in 1826: see Hope: Treatise, 3rd edit. p. 72, 1839.

adjusted so that no sound is produced by the blood-currents. But whatever contracts an orifice, whatever dilates a cavity, whatever establishes an orifice or a cavity where naturally none should be, will disturb the even flow of blood, and produce vibration and a murmur.[1]

The prime division of murmurs, audible over the heart, is drawn between those which are referable to the heart itself, its walls, orifices, cavities, and contained blood; and those which are referable to the great vessels next the heart. Hence the distinction between cardiac and vascular murmurs.

Class I.—Cardiac Murmurs.

The physical conditions of murmur are fulfilled, in the case of the heart, at its orifices, and there only. At least we know little or nothing of cardiac murmurs engendered elsewhere. Now the orifices of the heart are of two kinds, some are provided with valves, and some are not.

i. The Valvular Orifices.—Each valvular orifice both admits the blood and shuts it off; and, whether open or closed, may give rise to

[1] Corrigan: Inquiry into the causes of the bruit de soufflet and frémissement cataire. Lancet, April 4, 1829.

murmur. Murmur arises at an open orifice when its size is too small with respect to the cavity beyond: that is to say, the orifice is narrowed, or the cavity is dilated, or both these morbid states concur. Murmur arises at a closed orifice (or say rather, at an orifice which naturally should be closed), when it is not closed, but leaks, and allows the blood partly to pass back into the cavity whence it came. Murmurs produced at an open orifice, and in the natural current of the blood, are called onward, obstructive, or constrictive murmurs: murmurs produced at a closed orifice, and against the natural current of the blood, are called backward or regurgitant murmurs.

ii. The Non-valvular Orifices.—To wit, the orifices of the venae cavae, of the pulmonary veins, and the perforations of the auricular or ventricular septum found in congenital malformations, or established after birth. But all these non-valvular orifices are very seldom the cause of murmur. Murmur may perhaps arise at the mouth of a large vein when the related auricle is much enlarged, and the rush of blood is strong.[1] An open foramen ovale has some-

[1] See Markham's case, before cited (p. 43).

times seemed to be the seat of murmur.[1] Perforation of the base of the septum ventriculorum is attended by a loud murmur.[2]

Murmurs were once characterised according to their acoustic qualities, whether blowing, filing, rasping, sawing; but these are vain distinctions: in order to render murmurs serviceable in the diagnosis of disease we now regard two only of their properties, namely, their Place and Time.

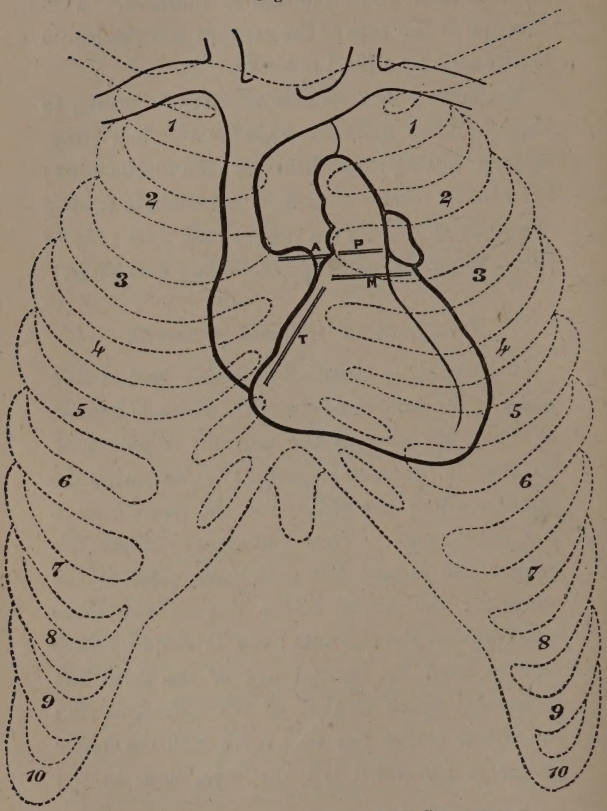
I.—Place of Cardiac Murmurs.

In general, a murmur is heard best at that point of the surface of the body which is nearest to the orifice whereat the murmur is generated. So that it becomes important to determine the relation which the orifices of the heart bear to the chest wall. The Pulmonary orifice lies behind the second left interspace, close to the sternum: the Aortic orifice lies on the same level, behind the sternum: the Tricuspid orifice reaches from the sternal end of the third left intercostal space to that of the fifth right rib: the Mitral orifice lies on a level with the upper border of the third left cartilage, close to the

[1] J. W. Ogle: Harveian oration for 1880: p. 100. London, 1881.

[2] Roger: See part ii. chapter 39.

Fig. 13.



Position of Heart with Reference to Chest-wall.

A = site of aortic valve.
M = mitral.
P = pulmonary.
T = tricuspid.

The direction of the rings, to which the bases of the aortic and mitral segments are attached, is obliquely upwards from right to left.

edge of the sternum, and slightly behind it. And let it be noted that the mitral orifice lies much more deeply than the rest.[1] But murmurs are not always conducted the shortest way to the surface. The conducting power of the tissues interposed between a valve and the chest-wall, and the direction of the blood current, have much to do with determining the point at which a murmur is heard loudest.

i. The influence of the superjacent tissues is well exemplified in the case of aortic and mitral murmurs. Both orifices of the left heart lie deep in the chest. The aorta becomes most superficial just above its valves, and is there almost in contact with a good conductor of sound, the sternum : wherefore aortic murmurs are well conducted up and down the sternum, and along the attached cartilages : so that, in fact, an aortic murmur is sometimes heard louder at the xiphoid cartilage than at the second intercostal space. The mitral orifice, buried beneath heart and lung tissues, may be said, for purposes of auscultation, to become most super-

[1] Sibson (Position and form of the heart and great vessels : Reynolds' System of Medicine, vol. iv. p. 14, 1877) seems to differ from most anatomists in his doctrine concerning the position of the valves.

ficial where the cavity of the left ventricle becomes most superficial, that is to say, at, or just above the apex of the heart; and here, as a rule, mitral murmurs are heard loudest.

ii. The influence of the blood-current also (or of convection, as it has been called[1]) is exemplified by both mitral and aortic murmurs. Obstructive and regurgitant aortic murmurs are well conveyed by the blood along the arteries, and a regurgitating murmur may be conveyed by the reflux of blood towards the apex of the left ventricle. Mitral regurgitant murmur is sometimes conveyed by reflux into the auricle, so as to be heard over the third left cartilage.

When the heart is displaced—that is to say, when the relation between its valves and certain points of the chest-wall is changed—the place of murmurs is likewise changed. This is not seldom the case in aortic regurgitation; to the chapter upon which disease refer.

II.—Time of Cardiac Murmurs.

A complete cycle of the heart's action may be divided into four periods. i. The Auricular

[1] Salter: On cases illustrating the influence of convection in determining the seat of cardiac murmurs. Lancet, July 24-Aug. 14, 1869.

period: not attended in health by any sound: the auricles contracting.[1] ii. The Ventricular period: accompanied by the first sound: the ventricle contracting. iii. The Arterial period: attended by the second sound: the aorta and pulmonary artery contracting. iv. The period during which all parts of the heart are at rest. The subject requires a further development, thus:—

	Auricular Period.	Ventricular Period.	Arterial Period.	Rest.
Relative duration. Pulse = 60.	$\frac{1}{10}$	$\frac{4}{10}$	$\frac{4}{10}$	
Valves cuspid	open	shut.		
Valves sigmoid		open	shut.	
Sounds		first.	second.	
Murmurs	præsystolic	systolic	diastolic.	

The time of murmurs is determined in two ways: by reference to the sounds and to the impulse of the heart.

i. By reference to the sounds, murmurs are

[1] Of late years, many physiologists have revived the old Galenical doctrine, that the ventricles dilate actively during their diastole, and so suck blood out of the auricles. See Revue des sciences médicales, vol. ix. p. 345, 1877. (De la diastole cardiaque, par A. Pitres.)

most accurately timed. When both of the heart-sounds are heard, it will not be difficult to say that a murmur precedes, accompanies or follows a certain sound. When one sound only is heard, we have to find out whether it be the first or second sound, and this is not always easy. When one sound only is heard at the apex, two sounds are sometimes to be heard at the base: the sound missing at the apex is commonly the second. When neither sound is heard at the apex, one sound (especially the second) or both sounds may be heard at the base.

ii. By reference to the impulse. Murmurs which accompany the impulse may be deemed systolic, in the absence of evidence to the contrary. Yet be it borne in mind that the impulse is not strictly systolic, but is also præsystolic and post-systolic.

iii. Less trustworthy means of determining the time of a murmur are these. By reference to the arterial pulse, especially in the neck. By reference to a valvular thrill, if any there be. In which case, the thrill and murmur being due to the same vibration, whatever the relation of the thrill to the impulse, such will the relation of the murmur also be.

The time of some murmurs is not constant.

This is true of mitral murmurs in particular: a murmur, præsystolic when the patient is first seen, may become systolic before long. But more of this hereafter.

III.—Meaning of Cardiac Murmurs.

i. Systolic murmurs referable to the Auriculo-Ventricular (or cuspid) orifices indicate reflux of blood: to the Arterial (or sigmoid) orifices indicate constriction at or just above the orifice, unevenness of the conus arteriosus, dilatation of the aorta, or perforation of the septum ventriculorum.

ii. Diastolic (and præsystolic) murmurs produced at the Cuspid orifices indicate constriction or obstruction of the orifice: at the Sigmoid orifices indicate reflux of blood, or dilatation of the vessel above the valve.

IV.—Loudness of Cardiac Murmurs.

i. Some murmurs, which are audible whilst a patient is lying, become much less loud or even disappear when he sits or stands. This is especially the case with mitral and tricuspid

murmurs. The reason of the occurrence is not understood.[1]

ii. Pressure upon the heart region sometimes makes a murmur weaker. On the other hand, pressure upon the upper part of the sternum or over the pulmonary artery will beget a systolic murmur in some young persons.[2]

iii. The loudness of some murmurs is under the influence of breathing; thus, a systolic apex murmur may be much louder during inspiration than during expiration; and a tricuspid systolic murmur may become inaudible at the beginning of expiration.

iv. Murmurs are loudest sometimes when the heart beats forcibly, sometimes when it beats quietly; they are sometimes inaudible except at these respective times.

v. The loudness of a murmur depends much

[1] Elliotson: Lectures: London Med. Gazette: vol. xii. p. 373: 1833.

Ringer: On the influence of posture on endocardial murmurs. Edinburgh Med. Journal, vol. vi. p. 689.

Gowers: On the influence of posture on præsystolic cardiac murmurs. Practitioner, Dec. 1873.

[2] P. M. Latham: Diseases of Heart, vol. i. p. 62, 1846.

W. Jenner: On the influence of pressure in the production and modification of palpable vibrations and murmurs perceptible over the heart and great vessels, larynx, and lungs. Med. Times and Gaz., Mar. 1856.

upon the swiftness of the blood-current: hence, when the current is weak and slow there may be no murmur, even although the valvular disease is great. Whatever weakens the contraction of the heart weakens the current: hence a murmur often becomes inaudible in the course of infectious fevers, in asystoly, in the dying state, and in other such conditions.

V.—Reduplication of Heart-Sounds.

A heart-sound is said to be reduplicated when, instead of being a single sound, it seems to be more or less doubled or repeated. Sometimes the sound is completely doubled, that is to say, in the place of one sound there are heard two sounds, with a distinct interval between them. But more often the reduplication is incomplete, or subintrant, that is to say, before the first portion of the doubled sound is concluded, the second begins. Thus, if the single heart-sound be likened to the syllable tup, the reduplicated sound would answer to tup-tup (complete), or to turrup (incomplete).

I. Simple Reduplications.—Most reduplications seem indeed to be nothing more than repetitions of a natural heart-sound, first or

second, as the case may be. The component elements of the sound are sundered more or less, and do not exactly concur in point of time. A reduplication of the second sound, for instance, is thought to be due to this want of keeping time in respect of the closure of the pulmonary and aortic sigmoids; the two second sounds are heard more or less apart from each other. The conditions of the first sound being uncertain, it is not safe to attempt an explanation of its reduplications. Potain,[1] however, has put forth a general theory of these simple reduplications, as follows. Intermittence is an almost constant character of reduplication, the sound being doubled with some beats of the heart, and not with others. This intermittence is found to bear a close relation with the movements of breathing: so that the first sound doubles at the end of expiration and the beginning of inspiration; the second, at the end of inspiration and the beginning of expiration.[2] Reduplication is due to asyn-

[1] Note sur les dédoublements normaux des bruits du cœur. L'Union Médicale, 1866, Nos. 97–115.

[2] A fact already noted by Schafer: Ueber die Auscultation der normalen Herztöne, 1860. See Canstatt's Jahresbericht for 1859, vol. ii. p. 100.

chronism in the closure of like valves, cuspid or sigmoid; the asynchronism is due to difference in the amount of pressure exerted upon each set of valves; and the difference of pressure depends upon the different states of respiration.

II. Reduplication Murmurs.—Were reduplications all of this simple kind, they would hardly need much notice. But many seeming reduplications of a heart-sound are indeed murmurs; that is to say, a murmur is added to the heart-sound, or a murmur is split into two sounds, so as to simulate the simple reduplications.

i. False Reduplication of First Sound.—Potain describes a cantering action of the heart (bruit de galop) in which the first sound seems to be doubled; the seeming reduplication being due to a weak præsystolic sound, which is well heard at the apex-beat only. This kind of cantering is, he thinks, a sign of granular kidneys.[1]

ii. False Reduplication of Second Sound.—Bouillaud was the first to describe a bruit de

[1] Potain: Du rhythme cardiaque appelé bruit de galop; de son mécanisme et de sa valeur séméïologique. L'Union médicale, vols. xx., xxi., 1875–6.

rappel, that is a seeming reduplication of the second sound, heard at the apex-beat. A præ-systolic murmur also is usually present; whether this be so or not in a given case, the double sound is to be looked upon as being a divided diastolic murmur, and a token of mitral constriction.[1]

Class II.—Vascular Murmurs.

i. A murmur, systolic, loudest in the aortic or pulmonary region, often occurs in the state of cachexia, apart from any permanent anatomical lesion. It is still a topic of debate whether the murmur be valvular[2] or vascular, or whether it be always due to the same condition. If it be vascular, the following is the most likely explanation. Cachexia or poorness of blood implies diminution of the quantity of blood in the body; and diminished quantity of blood involves the following results:—i. The blood-channels adapt themselves to the oligæmia: the capillaries, the small arteries and veins, the heart and its orifices

[1] Hilton Fagge: On the murmurs attendant upon mitral contraction. Guy's Hospital Reports, series 3, vol. xvi., p. 247, 1871.

[2] Refer to chapters on Mitral and Tricuspid Regurgitation.

become proportionally diminished in size, but the large arteries, being less contractile, are not proportionally diminished in size; that is to say, they become relatively dilated. ii. The diastolic pressure of blood upon the sigmoid valves is diminished: hence the systolic flow into the arteries meets with less resistence than natural, and so becomes swifter.[1] Now these are the conditions of a murmur, as before explained.

ii. A murmur, diastolic, loudest in the aortic region, is sometimes associated with nothing more than rigidity and dilatation of the aorta, the valves being healthy.[2]

iii. A murmur is sometimes due to lasting openness of the ductus arteriosus.[3]

iv. A murmur, diastolic, loudest over the fourth left cartilage, is sometimes due to an opening formed between an aortic aneurysm and the pulmonary artery.[4]

[1] Chauveau: Des bruits de souffle dans les anémies. Gazette médicale de Paris, 1858, pp. 340 et sqq.

[2] See part ii. chapter 33.

[3] See part ii. chapter 39.

[4] Wade: On a case of aortic aneurysm, in which a communication with the pulmonary artery was recognised during life by means of physical diagnosis. Medico-chirurgical Transactions, vol. xliv. p. 211, 1861.

¶ II.—PERICARDIAL SOUNDS.

No sound is produced by the movement of healthy pericardial surfaces upon each other.

In diseased states of the pericardium two kinds of sounds may be heard: friction sounds, and sounds due to the presence of air and liquid in the cavity.

I.—PERICARDIAL FRICTION.—It is convenient to consider pericardial friction sounds with reference to their diagnosis from endocardial sounds. The most important diagnostic characters of friction sounds are these :—

i. The special quality sometimes suffices for the diagnosis, being distinctly rubbing or scraping: but often enough this quality is ill-marked or absent. ii. Friction sounds are mostly of limited extent, heard over a small portion only of the heart region, especially at the base of the heart; they do not follow the laws laid down with regard to the points of greatest intensity, and the conduction of endocardial murmurs. Indeed, there is no part of the heart-region where friction sounds may not be heard loudest. A very loud friction sound may be heard, not only all over the heart-region

but even all over the front of the chest, nay even at the angle of the scapula: though, in these latter cases, there is mostly marked and sudden weakening of the sound so soon as we pass away from its place of origin. Friction-sounds which at first on account of their place and their quality, simulate murmurs, sometimes shift their place, so as to become loudest at spots where murmurs are seldom heard loudest. A sound which shifts its place from day to day is pericardial. iii. Friction sound is mostly systolic and diastolic, being loudest in the systole; sometimes systolic only, or even diastolic only. A sound, which is at one time systolic and anon diastolic, is pericardial. iv. Friction-sounds are not intermittent like reduplications. v. The unchanged heart-sounds are sometimes heard through friction. vi. Friction-sounds often give a notion of superficiality, be it explained as it may. vii. Palpable vibration sometimes attends them. viii. Their loudness is sometimes increased, sometimes decreased, sometimes stopped, by deep inspiration. ix. Their loudness is sometimes increased, sometimes decreased, by pressure. x. Friction-sounds may be modified by change in the position of the body. Their place of greatest loudness may be thus made to

change: this is very characteristic.[1] Friction sound sometimes disappears when the patient sits up, possibly on account of a small quantity of fluid which comes forward so as to separate the pericardial surfaces: but it has been shown that the same change in position sometimes removes endocardial murmurs. Friction sound, not to be heard otherwise, is sometimes produced when the patient lies upon his left side, whereby the position of the heart is much changed.

Whatever roughens the pericardium can produce friction sound: excessive vascularity, exudations, hæmorrhages, adhesions, and white patches.

II.—WATER-WHEEL AND SIMILAR SOUNDS.—In the uncommon condition of effusion of liquid and air nigh to the heart, whether within the pericardium or outside it, peculiar sounds are heard.[2] Their character differs much in different cases. Sometimes they resemble the amphoric pleural sounds, namely, amphoric hum (attending the heart-sounds or friction),

[1] Oppolzer: Vorlesungen über specielle Pathologie und Therapie, vol. i. p. 26, 1866.

[2] The newest monograph upon this topic is: Reynier: Recherches cliniques et expérimentales sur le bruit de moulin, symptôme d'épanchement intra et extra-pericardique dans les traumatismes de la poitrine. Paris: 1880.

metallic tinkling, and splashing. Sometimes the sound is like a rale, bubbling or gurgling. Sometimes the sound is clacking or chopping, like the noise made by the floats of a water-wheel (bruit de moulin). All these sounds are alike in this, that they depend upon the movements of the heart, are independent of the breathing movements, and persist when the breath is held. When the pericardium is uninjured, the sound does not last more than three or four days.

Appendix to Section III.

In this place I will speak of sounds which, although dependent upon the movement of the heart, are neither cardiac murmurs nor pericardiac friction sounds.

¶ I. Pulsatile Pulmonary Sounds, that is to say, pulmonary sounds produced or altered by the movement of the heart or of the great vessels.[1]

i. The respiratory sounds of the healthy left lung may be so affected by the movements of the heart as to simulate its murmurs. The conditions of this occurrence are not well under-

[1] Laennec: Auscultation médiate, vol. ii. p. 446, describes altered breathing sounds and crepitation. See the

stood: pleural adhesions, such as to fix the lung over the pericardium, are often present. The diagnosis lies, not in the quality of the sounds, but in the fact that they concur with a certain respiratory movement, as well as with a certain cardiac movement. They are mostly systolic and inspiratory; less often diastolic, or expiratory. They usually cease to be produced when the breath is held. They are sometimes heard only in the upright posture of the body:[1] but as a rule they are rendered less loud, or they even disappear, on changing the lying posture for the erect.[2]

ii. The respiratory sounds of a cavity (phthisical, bronchial, or pneumothoracic), may be altered by the movements of the heart or aorta in a similar manner. These false murmurs also are mostly inspiratory and systolic, or systolic and diastolic; seldom expiratory. They are heard best over the cavity, but they are some-

later literature of the subject in Friedreich: Krankheiten des Herzens. 2nd edit. p. 89. Also, Landois: Graphische Untersuchungen, pp. 16, 29, 36.

[1] In a case of palpitation of the heart, I heard a systolic inspiratory murmur, probably of this kind, at the angle of the left scapula, and not elsewhere.

[2] Cuffer: Des causes qui peuvent modifier les bruits de souffle intra et extra-cardiaques: p. 53. Paris: 1877.

times conducted far, even over the whole chest. And, in the case of phthisical cavity, even along the windpipe to the mouth, so as to be heard at a distance from the patient, when the mouth is opened widely.[1] The cavity is either close upon the heart and aorta, or is connected with them by a solid mass (such as solidified lung, or enlarged lymphatic glands), which is apt to convey the cardiac movements. In cases of phthisis, a strong aortic impulse can sometimes be felt where the false murmur is heard: for instance, in the third right intercostal space, close to the sternum.

iii. Rales also may be produced, and especially crepitation. It is systolic, and is most likely due to the entry of air into vesicles partly or wholly collapsed, the movement of the heart causing a local inspiration in the portion of lung which lies upon the pericardium. The crepitation ceases to be produced when the breath is held after a deep expiration.

¶ II. Pulsatile Friction Sound generated in the pleura, of both respiratory and cardiac rhythm, sometimes is heard. Friction heard behind or alongside the sternum, from the

[1] F. Taylor: An unusual case of cardio-pulmonary bruit. Clinical Society's Trans. vol. xiii. p. 365, 1880.

second to the sixth rib, is most likely pericardial. When a friction sound is heard at other parts of the heart-region, the diagnosis is not easy: pleural friction usually ceases when the breath is held, but this is not always the case; and there is no doubt that true pericardial friction may sometimes be stopped in that manner.

¶ III. By the name of Metallic Jingle, Laennec[1] meant the sound which is heard when the stethoscope is applied to the chest, whilst some bony part near by (such as the clavicle or spine) is percussed. When the palm of the hand is put over the ear and the back of the same hand is tapped, we hear a very loud metallic jingle. A sound of the same kind is sometimes heard when we listen to a heart which is beating forcibly: in this case, it is commonly supposed that the stroke upon the ribs causes the sound. For my own part, I suspect that resonance of the meatus auditorius externus has much to do with the production of a metallic jingle.

Auscultation as applied to the large vessels of the mediastina will be treated of hereafter.

[1] Auscultation médiate, vol. i. p. 114, and vol. ii. p. 445; cliquetis métallique.

CHAPTER VI.

APPENDIX TO PART I.

SECTION I.

AUSCULTATION OF THE ARTERIES.

TWO kinds of sounds are heard by auscultation of arteries: conducted sounds, and murmurs produced in the part ausculted.

I. CONDUCTED SOUNDS.—The heart's sounds and murmurs, especially the second sound, and aortic or mitral murmurs, are conducted along the arteries; not usually, however, farther than the carotids and subclavians. Yet very shrill diastolic murmurs produced at the aortic orifice, may sometimes be heard so far away as in the radials.

II. MURMURS PRODUCED IN THE SPOT AUSCULTED. — These are either spontaneous or factitious.

¶ I. Spontaneous Arterial Murmurs.—These are aneurysmal or subclavian.

i. Aneurysmal.—The systolic murmur which is sometimes produced in an aneurysm, is be-

lieved to be due to the formation of a fluid vein at the mouth of the aneurysm. The formation of a fluid vein requires that the cavity containing fluid blood be considerably wider than the mouth of the sac, and that the blood current be swift enough.

ii. Subclavian.—A systolic murmur, seated in the subclavian artery, is often to be heard below the clavicles, mostly on the left side. The murmur is favoured by expiration, weakened or altogether removed by deep inspiration or by raising the arm to a right angle with the body. Subclavian murmur is often very inconstant or temporary. Its conditions are not known.

¶ II. Factitious Arterial Murmurs, due to compression of the artery by the stethoscope, are systolic or diastolic.

i. Systolic Murmur.—In healthy persons, a slight compression of the larger arteries will generate a soft murmur, systolic with reference to the left ventricle. In some forms of disease, notably in hypertrophy of the left ventricle and in chlorosis, firmer pressure makes the murmur harsh and whizzing. Moreover, under these conditions, a murmur is producible in the smaller arteries; such as the plantar and the volar.

ii. Diastolic Murmur has long been known;[1] but Duroziez was the first to study it more particularly.[2] It is best heard in the femoral artery, and attends a certain degree only of pressure: a degree which must be discovered in each case by varying the amount of force used to compress the vessel. A loud systolic murmur precedes the softer diastolic sound. It is often present in cases of aortic regurgitation; and is probably due to reflux of blood along the artery, during the ventricular diastole. A certain amount of pressure upon the artery above the spot ausculted renders the systolic murmur louder; the reason being that a second fluid vein is thus produced. The diastolic murmur is rendered louder by compression of the artery below the spot ausculted, probably because the diastolic reflux is favoured thereby.[3] Yet double femoral murmur sometimes occurs apart from any signs of valvular disease: in this case the

[1] Beau: Traité, pp. 375, 431.

[2] Duroziez: Du double souffle intermittent crural, comme signe de l'insuffisance aortique. Archives générales de médecine: series v., vol. xvii. 1861. The vast extent of the literature which has been devoted to this very insignificant topic is amazing.

[3] An observation first made, I believe, by Alvarenga, whose book on diseases of the heart I have not seen.

condition has been supposed to lie in a highly dicrotic pulse; the diastolic murmur corresponding with the secondary pulse wave.

It is necessary to bear in mind that diastolic murmur, produced at the aortic orifice, is sometimes conveyed to great distances along the arteries. But diastolic murmur of this kind requires no compression of the artery to make it audible.

SECTION II.

INSPECTION OF THE VEINS OF THE NECK.

Inspection of the veins of the neck is directed to two points; the fulness of the veins, and the movements which the contained blood undergoes.

¶ I.—THE FULNESS OF THE VEINS.

In health the external jugular alone is visible, and even that vein, oftentimes, only in the lying posture. In disease both veins are sometimes dilated to the size of a finger. Overfilling of the veins is either transitory or permanent.

i. Transitory overfilling accompanies powerful expiratory movements; which produce such an amount of pressure within the intrathoracic

veins, that the valves at the mouths of the jugular veins are shut, and the blood flowing down from above cannot pass into the innominata. Inspiration reverses all this; the veins are emptied, and collapse. Repeated transitory overfilling of the veins is followed at last by permanent dilatation of them, a fact seen in patients who suffer from chronic pulmonary catarrh. If in these persons when there is no cough and the veins are invisible, we place our finger just above the clavicle so as to obstruct the external jugular vein, it at once swells up and manifests the amount of its dilatation; which may be taken as a mark of the degree to which the patient's tissues have suffered in consequence of cough.

ii. Permanent overfilling of the jugulars is mostly associated with overfilling of the right auricle; but, obviously, any obstruction to the upper vena cava, or to the innominata (by compression, thrombosis, or stricture) will have the same effect.

¶ II.—MOVEMENTS WITHIN THE VEINS.

Besides the respiratory movements which have just been described, the blood within the veins

often undergoes movements which are dependent upon the heart's contractions. Venous pulsations are præsystolic or systolic.

i. Præsystolic pulsations[1] can be seen in the jugular veins of some healthy persons when lying down. The cause of the pulsation is supposed to be the contraction of the right auricle.[2] Whether the valves of the veins are competent or not makes no difference: when they are competent the impact of blood upon them from below is sufficient to agitate the blood contained in the veins above.

ii. Systolic pulsation in the veins is due to the ventricular systole, indirectly or directly. A direct systolic pulsation (venous pulse) signifies a reflux of blood out of the ventricle; the tricuspid valve being incompetent. When the valve is competent, we may call the pulsation indirect. Both præsystolic and systolic pulsations are often most, and sometimes only, visible when the veins are fullest, that is, at the beginning of inspiration.

[1] Parrot: Étude sur le siège, le mécanisme, et la valeur séméïologique des murmures vasculaires inorganiques de la région du cou. Archives gén. de Médecine, June, 1867, p. 649.

[2] But Luciani denies the reflux into the venæ cavæ during the auricular contraction. Hayem's Revue des Sciences Médicales, vol. ix. p. 347.

a. Indirect systolic pulsation is mostly due to the fact that the tricuspid valve is raised, by the ventricular systole, into a sort of dome, convex towards the auricle. Hence an impulse backwards to the blood in the venous system; counteracted however, unless the overfilling of the veins be very great, by the diastole of the auricle. Friedreich suggests that in some cases the systolic filling of the aorta compresses the distended intrathoracic veins, and thus produces a movement in the jugulars.[1] The pulsations of the carotid artery often enough communicate systolic movements to the veins; but compression of the vein at the clavicle does not stop movements of this kind, and does stop movements transmitted upwards along the vein.

β. Direct systolic pulsation, being due to the propulsion of a wave of blood from the right ventricle into the jugular veins, requires that both tricuspid and venous valves be incompetent.[2] It is easy to ascertain whether the

[1] Die Krankheiten des Herzens, 2nd edit., p. 53. 1867. In Virchow's Handbuch des speciellen Pathologie und Therapie.

[2] Joh. M. Lancisii, De motu cordis et aneurysmatibus. Lugd. Bat. 1740. Propos. lvii. "Inquirere mechanicam rationem, ob quam in dilatationibus radicis Cavæ, Auriculæ, et Ventriculi dextri, ipsæ venæ Jugulares vicissim dilatentur, fluctuent, mirisque modis agitentur, et con-

venous valves are competent or not; namely by compressing the veins in the upper part of the neck, and observing whether they are filled with blood from below or not. But it is not so easy to determine reflux through the tricuspid valve; that is, to distinguish between direct and indirect systolic pulsation. The difference is only one of degree. Both pulsation and filling from below are less marked when indirect than when the tricuspid valve is incompetent: for in the latter case blood is pumped out of the ventricle into the veins under strong pressure. To repeat: when the pulse is strong there is probably tricuspid regurgitation; when the pulse is weak it may be independent of reflux from the ventricle. When the pulse is very strong, it is sometimes palpable, or even thrilling.[1]

By Bamberger, Friedreich,[2] and others, the

cidant." The cause is asserted to be a regurgitation of blood through the tricuspid valve. Lancisi refers to Hombert as having made the same observation in a paper published in the Proceedings of the Parisian Academy of Sciences in 1704.

[1] In the case of rupture of an aortic aneurysm into the vena cava superior, systolic pulse and thrill are present in the veins of the neck.

[2] Bamberger: Beobachtungen über den Venenpuls. Würzburger med. Zeitschrift, vol. iv. p. 232. 1863.

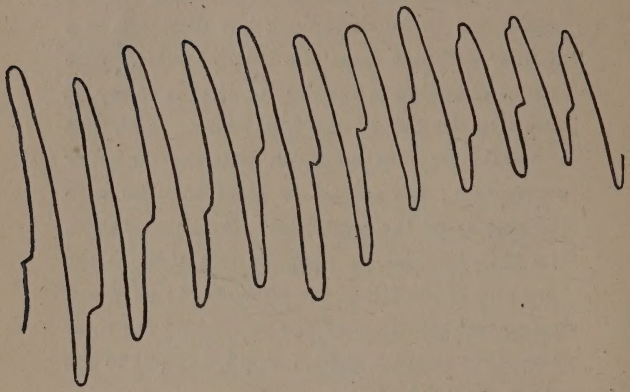
sphygmograph has been applied to jugular veins strongly pulsating. The venous pulse has thereby been found to be dicrotous; but dicrotous in a manner different from the arterial pulse. The venous dicrotism is anadicrotic, that is to say, it occurs in the rise of the blood-wave. The first or smaller impulse coincides with the auricular contraction; the second or chief impulse with the systole of the ventricles. Sometimes there is a katadicrotism, or diastolic dicrotism, at the very end of the fall of the pulse-wave: supposed to indicate repletion of the cavities of the right side of the heart, a sudden stop being put to the entry of more blood.

iii. Sudden collapse of the jugular veins, during the ventricular diastole, has been seen by Friedreich[1] in some cases of pericardial adhesion. The sign, which is always preceded by systolic recession of the chest walls, consists in this, that the veins, full during the systole, suddenly collapse so as to become almost or quite invisible during the diastole. The supra-clavicular regions sometimes sink at the same

Friedreich: Ueber den Venenpuls. Deutsches Archiv für klin. Med., vol. i. p. 241. 1866.

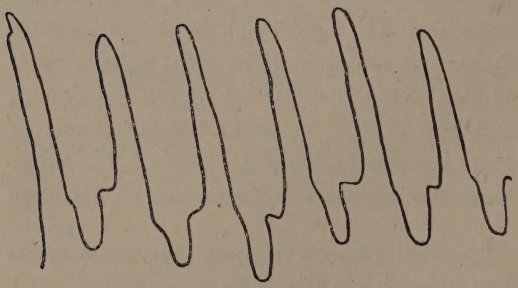
[1] Zur Diagnose der Herzbeutel-verwachsungen: Virchow's Archiv, vol. 29, p. 296. 1864.

Fig. 14.



Tracing of Anadicrotic Jugular Pulsation.

Fig. 15.



Tracing of Anakatadicrotic Jugular Pulsation.

time. Friedreich supposes that the diaphragm, drawn upwards by the adherent heart during the systole, and returning to its former position during the diastole, elongates the intrathoracic veins, and so sucks the blood out of the jugulars.[1]

SECTION III.

AUSCULTATION OF THE VEINS.

I. THE VEINS OF THE NECK.—By means of a stethoscope placed upon the side of the neck, there is often to be heard a humming sound; which was first referred to the veins by Ogier Ward.[2] This venous hum is usually continuous; but other murmurs, which are intermittent, are occasionally heard in the veins.

¶ 1. The Continuous Venous Hum, although especially well heard in chlorotic patients, occurs in a large number of healthy persons. Pressure with the stethoscope is doubtless a frequent

[1] Pulsation of the veins on the back of the hands, due to the impulses from the left ventricle transmitted through the capillaries, is sometimes, though seldom, seen in cases of great weakness or of great valvular disease.

[2] On the bruit du diable. Lond. Med. Gaz. 1837, p. 7.

cause of the murmur. But a venous hum, in chlorotic persons, is independent of pressure, and is believed to depend upon anatomical conditions. The internal jugular vein is adherent, at its lower end, to the cervical fascia, in such a manner that, when the venous system shrinks in capacity and adapts itself to a lessened bulk of blood, the part of the vein spoken of cannot shrink, and so becomes relatively dilated: hence a sonorous fluid vein.[1] The more rapid the flow of blood the louder the hum: hence it is louder in the erect than in the lying posture; and is stopped by whatever produces stagnation of blood in the vein. Hence, also, in most cases, although the murmur is continuous, yet it is subject to rhythmical increase of loudness; both during the inspiratory draught of blood from out the veins; and during the ventricular systole, that is, during the auricular diastole, when the venous current begins again to flow freely.

¶ II. Intermitting Venous Murmurs of the neck are scarcely worth mention.

i. Præsystolic murmurs due to the passage of blood backwards through the mouth of the

[1] Chauveau: Des bruits de souffle, cited on p. 167.

internal jugular vein, can be heard, according to Parrot,[1] in all persons when lying down.

ii. Systolic murmurs often exist at the root of the neck in cases of tricuspid regurgitation. Parrot declares that a double murmur, præsystolic and systolic, can be heard in such cases.

iii. Diastolic murmurs have been described, by Friedreich, as occurring occasionally in the internal jugular.[2] Hypertrophy of the heart, dilatation and strong pulsation of the aorta, and an anæmic state, are the conditions necessary to the presence of this murmur. It is supposed to be due to pressure of the aorta upon the vena cava or innominata, during the diastole. The murmur has been heard in two cases only, one a case of aortic regurgitation, and the other of exophthalmic goitre.

II.—THE FEMORAL VEINS.

¶ 1. Systolic, diastolic, and præsystolic murmurs have been heard in the femoral veins also: especially in cases of tricuspid regurgitation.[3]

[1] Étude, cited on p. 180.

[2] Die Krankheiten des Herzens, 2nd edit. p. 96.

[3] Schreiber: Entstehung und Bedeutung der Doppeltöne im peripheren Gefässsystem. Deutsches Archiv für klin. Med. vol. xxviii. p. 243. 1881.

¶ II. An expiratory murmur, supposed to be a sign of incompetence of the valves at the top of the femoral vein, may be detected thus. Evert the thigh, and place the finger or the stethoscope, lightly upon the vein, just below Poupart's ligament. Then bid the patient cough, and each time he coughs, a marked thrill, and a murmur, will be perceived.[1] This lesion is thought to be a common cause of varix.

SECTION IV.

EPIGASTRIC PULSATION.

¶ I. Pulsation of the epigastrium depends upon—

I. Conduction thereto of the impulse of the heart: i., when it is beating more strongly than usual: ii., when it is dilated: iii., when it lies lower than natural; a condition mostly due to depression of the diaphragm:[2] iv., when it is displaced to the right.[3]

[1] Beau: Traité, p. 416. 1856.
Friedreich: Insufficienz der Cruralvenenklappen. Berlin. klin. Wochenschrift. 1874, no. 48, p. 611.

[2] See next section.

[3] See p. 44.

II. Pulsation of the abdominal aorta, or of the cœliac axis, or of an aneurysm, or of a tumour seated upon the abdominal aorta.

III. Regurgitation of blood into the hepatic veins, consequent upon dilatation of the right side of the heart; a phænomenon first observed by Senac.[1]

¶ II. Recession of the epigastrium, systolic, occasionally simulates pulsation, and when well marked is probably due to pericardial adhesions.[2]

SECTION V.

THE POSITION OF THE DIAPHRAGM.

In many diseases of the chest, it becomes an important element in the diagnosis to ascertain the position of the diaphragm. Strictly speaking, we determine the lower limits of the lungs and heart, the upper limits of the liver, spleen, and stomach, and deduce the position of the diaphragm from these data. For this purpose all the means of physical examination are more

[1] Burns: Observations on some of the most frequent and important diseases of the heart: p. 262. Edinb. 1809.

[2] Associated, in Copland's case (cited on p. 34), with cup-shaped depression of the sternum.

or less serviceable, but percussion is especially useful.[1]

¶ 1. In Health.—By inspection, the position which the diaphragm held before puberty may be roughly determined.[2] By palpation, the position of the heart's apex-beat, and the point where vocal vibration ceases, are ascertained. By percussion, the lung, at the end of an ordinary inspiration, is found to reach, in the sternal line the lower border of the sixth rib, in the nipple line the upper border of the seventh rib, in the axillary line the lower border of the seventh rib, in the scapular line the ninth rib, and in the spinal groove the eleventh rib. The lung, during quiet breathing, fills not the whole pleural cavity, but leaves it unoccupied at the part most distant from the bifurcation of the bronchi, namely, at the semicircular channel formed by the chest wall and the diaphragm where it shelves downwards to be attached to the ribs. This unoccupied portion of the pleural sac has been named the complemental space; there the costal and diaphragmatic pleuræ are in contact.

[1] Gerhardt: Der Stand des Diaphragmas: physikalisch-diagnostische Abhandlung. Tübingen, 1860.

[2] See p. 16.

¶ II. In Disease.—The disease may be such as to afford an obvious impediment to physical diagnosis, by destroying the resonance of the parts above the diaphragm. Which is the case in solidification of the lower lobe of the lung, and in liquid pleural effusion. When the lung is solidified, vocal thrill, if present, will assist us, inasmuch as it fails rapidly beyond the pulmonary region. When liquid is present in the lower part of the pleura, it is impossible to do more than guess where the level of the diaphragm may be. The diaphragm lies high in:—contraction of the lung, distension of the abdomen, paralysis of the diaphragm. The diaphragm lies low in:—hypertrophous emphysema of the lungs, pleural effusions, dilatation of the heart, pericardial effusions, intrathoracic tumours, spasm of the diaphragm. A greatly enlarged heart or an abundant pericardial effusion may depress the diaphragm so much as to produce a tense swelling in the epigastrium: a fact known to Auenbrugger.[1] Depression of the right wing of the diaphragm sometimes depresses the right lobe of the liver in such a manner that the left lobe is tilted upwards and raises the apex-beat of the heart.

[1] Inventum Novum, § 46.

SECTION VI.

THE POSITION OF THE MEDIASTINUM.

The position of the mediastinum is determined in the same manner as the position of the diaphragm, namely, by ascertaining the position of the organ which is most intimately connected with the mediastinum, that is the heart. By palpation we discover the position of the apex-beat of the heart: by percussion we are enabled to confirm the notions acquired by palpation, and to map out the position assumed by the heart. The mediastinum is displaced in unilateral pulmonary or pleural disease; and the displacement is either towards or away from the seat of disease. The mediastinum is displaced towards the seat of disease when one lung is shrunken: this is especially seen in phthisis, induration of the lung, and collapse, but also, to a less extent, in an adherent pleura. The mediastinum is displaced away from the seat of disease, in unilateral pleural effusions of liquid or gas. When the effusion is liquid we possess an additional means of determining the position of the mediastinum, to wit, percussion of the sternal region above the heart. The

upper part of the sternum naturally yields a clear resonance: under the pressure of a copious liquid effusion into either pleura, the mediastinum bulges so much towards the unaffected side, as to afford absolute dulness to percussion in the sternal region, and even somewhat beyond it. Intrathoracic tumours sometimes displace the heart.

Dr. Powell[1] has shown that the displacement of the mediastinum, which takes place in unilateral pleural effusions, is not at first due to the pressure exerted by the effusion. The lungs, in health, are in a state of distension which is kept up by excess of atmospher c pressure from within; the thoracic walls bearing off the atmospheric pressure from without. The elasticity of the lung is continually striving to overcome this distension, as is manifested by the relaxation of the lung which ensues when the internal and external atmospheric pressures are equalised. The distended lungs of the healthy chest, with their elasticity in full play, drag upon the mediastinum; which, however,

[1] Notes on the pneumothorax occurring in phthisis. London, 1869; or Med. Times and Gazette, Jan., Feb. 1869.

On some effects of lung elasticity in health and disease. Med. Chir. Trans., vol. 59, p. 165. 1876.

maintains its natural position, because the forces on both sides are equal. But if the elastic traction of one lung be destroyed by relaxation or collapse, the other lung, no longer counterbalanced, itself relaxes as much as possible, and draws the mediastinum away from the middle line.

SECTION VII.

THE HEIGHT OF THE PULMONARY APICES.

The height to which the lungs reach is determined by percussion of the supraclavicular and suprascapular regions.[1]

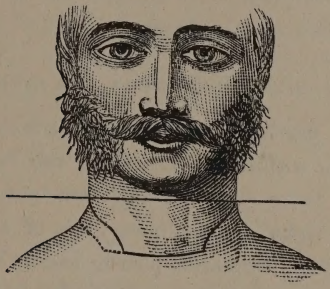
¶ 1. In Health.—The resonance ceases at a line drawn, from the insertion of the sternomastoid muscle, obliquely upwards to the anterior margin of the trapezius, thence round the muscle, in a line curved with its convexity downwards, to the vertebra prominens. Under the trapezius, the resonance reaches $1\frac{1}{4}$ to 2 inches above the clavicle: the height is mostly equal on both sides, but there may be

[1] Seitz (autore Heyer): Ueber die percussorische Grenzbestimmung der Lungenspitze. Giessen, 1863. Referred to by Paul Niemeyer; Handbuch der Percussion und Auscultation. Bd. i. 1868.

a difference of half an inch in favour of the right side.

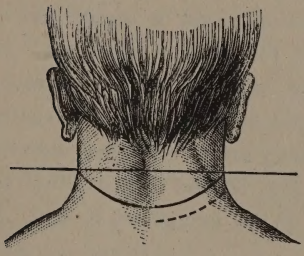
¶ II. In Disease.—The apex rises unnaturally

Fig. 16.



Height of Pulmonary Apices.

Fig. 17.



Height of Pulmonary Apices.

high, and bulges, in pulmonary emphysema: it shrinks both vertically and transversely, in

phthisis. The practical value of determining the size of the pulmonary apices lies in the diagnosis of commencing phthisis.

SECTION VIII.

VASCULAR MURMURS IN THE LUNGS.

Very probable though the occurrence of murmurs within the vessels of the lungs may be, yet twice only has the fact been proved. In the right supraspinous fossa of a phthisical patient, Gerhardt heard, beside bronchial breathing and ringing rales, a systolic whiff; which was explained, post mortem, by the existence of a dilated branch of the pulmonary artery, running across a cavity, and expanded in one spot to a small aneurysm.[1] Between the scapulæ and vertebræ Immermann once heard systolic murmurs, due to constriction of the pulmonary arteries at their entry into the lungs, and just beyond; constriction caused by induration of the pulmonary tissue.[2] Murmurs

[1] Lehrbuch, 3rd edit. pp. 218, 270.

[2] Strictur beider Hauptäste der Lungenarterie und ihrer ersten Verzweigungen in Folge chronischer interstitieller Pneumonie. Deutsch. Arch. für klin. Med., vol. v. 1869.

of similar character, and presumed to be of similar origin, have been heard by many other persons.[1] There is reason to believe that, in all cases, the branches of the pulmonary artery constitute the seat of the murmur; which, although most frequently heard in phthisis, may be present also in lung simply collapsed, and in pneumonia.

SECTION IX.

PUNCTURE OF THE CHEST.

Since the discovery of auscultation, no more important addition has been made to our means of physical examination than the method of probing the chest by puncture.

The end proposed is to detect collections of

[1] Cejka: Beobachtungen über das Nonnengeräusch. Vierteljahrschrift: Prag., vol. xxvi. 1850. A murmur, heard between the upper inner angle of the scapula and the vertebræ, attributed to the underlying veins.

Wintrich: Einleitung, p. 171. A murmur, apparently due to the same cause as that described by Immermann, but heard near the heart in front.

Bartels: Ueber systolische Gefässgeräusche in den Lungen. Deutsches Arch. für klin. Med., vol. vi. p. 111. 1869. Narrates several cases believed to exemplify murmurs generated in the branches of the pulmonary artery.

liquid within the chest; pleural effusions, pericardial effusions, and hydatid cysts.

The instrument employed is a small glass syringe, holding half a drachm or a drachm, and fitted with a hollow steel needle an inch and a half or two inches long, and as fine as is consistent with due strength. For the discovery of deeply-seated hydatid cysts, the length of the needle must be not less than six inches. The exploring aspirator, invented by Dr. Hensley, affords the advantage of enabling us to convert the exploration into a paracentesis, without change of instruments, and at one operation, if the liquid be thin enough to run through a fine cannula.

The place chosen for puncture is that where the liquid is supposed to be: due regard being paid to the anatomy of the parts within, so as to beware of wounding the heart, diaphragm, or large vessels. To pierce the lung with a fine needle is harmless. Indeed I may say, as the outcome of a very large experience, that I do not remember a single instance of a patient having been left the worse for an exploratory puncture.

i. When a pleural effusion is suspected, the puncture should be made where the signs of

disease are most marked. But, if possible, let the spot chosen be somewhere between the angle of the scapula and the edge of the pectoralis major, and not much below the nipple level.

ii. When the effusion is pericardial, the only rule which can be laid down is to puncture where the bulging is greatest. By reference to cases which have been published, it will be seen that puncture has been made in the most diverse places.[1]

iii. When a hydatid cyst is suspected, the rule seems to be to pierce the lung deeply and fearlessly with a long needle: at least this is the practice in Australia, where the disease is common.[2]

The needle may enter a phthisical or other suppurating cavity within the lung, and the syringe draw off a little pus or muco-pus. When the diaphragm is much pushed upwards by a large abscess between it and the liver, and when,

[1] Steavenson: Paracentesis pericardii. St. Barthol. Hosp. Reports, vol. xvii. p. 217. 1881.

[2] S. Dougan Bird: On hydatids of the lung, their diagnosis, prognosis, and treatment. 2nd edit. Melbourne. 1877. Says that puncture for hydatids of the lung was first described by R. F. Hudson, in the Australian Med. Journal for April, 1861.

as is often the case, an empyema of the lower part of the right pleural cavity is also present, the exploring needle sometimes passes right through the pleural empyema and the diaphragm, so as to obtain pus from the abdominal empyema only. Subcutaneous emphysema sometimes follows puncture of the chest, either in old pleural adhesions or in pneumothorax.

PART THE SECOND.

CHAPTER I.

PULMONARY CATARRH, OR BRONCHITIS.

§ I. Respiratory sounds weakened, and rales: these are the signs of catarrh.

¶ I. Weakening of the respiratory sound is general or local: that is to say, the whole of both lungs, or only a part of them, is so affected. i. Local weak breathing is by far the commoner condition; is due to the presence of mucus in the tubes; may amount to complete suppression of sound; is usually moveable in seat; and of short duration at any spot. ii. General weak breathing is due to swelling of the mucous membrane, or to weakened respiratory movements.

¶ II. Rales are of two kinds, sonorosibilant and mucous. Both kinds hide the respiratory sound more or less. i. Sonorous and sibilant

rales indicate local incomplete obstruction of the larger air-passages by mucus: a cough, by removing the mucus, mostly removes the rale. ii. Mucous rales indicate the presence of a larger amount of mucus in the tubes. The seeming size of the rale is usually proportionate to the size of the tube wherein the rale is produced. A mucous rale requires that the respiration be fairly vigorous: when the ebb and flow of air are much impeded the rale is imperfectly developed (obscure rale): a deep breath will sometimes change an obscure into a distinct rale. Often enough there are no rales at all, even when the expectoration is profuse.

§ II. i. Uncomplicated pulmonary catarrh is bilateral, affecting both lungs: the mucous rales, when present, are most abundant behind and at the bases of the lungs, or indeed exist there only. Yet now and then, and in simple bronchitis too, an abundant rale is heard for a short time in one lung only. However, persistent localisation of the signs of catarrh to one lung, or to parts of the lungs other than the bases, is an almost sufficient proof that the catarrh is determined upon that particular spot by some other disease. ii. Severe pulmonary catarrh is attended, especially in very young or

rickety children, by all the signs of inspiratory dyspnœa, namely recession of the epigastrium, of the ribs and cartilages below the nipples, and of the supraclavicular spaces. iii. In the same class of patients, acute emphysema or insufflation of the lungs is sometimes rapidly produced ; it is indicated by bulging of the front of the chest.[1] iv. The percussion-note is often impaired, for a few days, even over the whole of a lung, more commonly over a part only, especially the apices, the lower lobes, and the middle lobe of the right lung : associated collapse being the most likely cause. On the other hand, in both children and adults, patches of unnaturally clear resonance may be met with ; probably due to local relaxation of the lung-tissue. v. When catarrh is complicated by disseminated solidifications of the lungs (especially lobular pneumonia and miliary tuberculosis) the rales sometimes acquire a sharp ringing reverberating quality. Dilated tubes produce the same effect, but this lesion is very uncommon compared with scattered consolidations. vi. The deformities, produced by catarrh, are sometimes permanent. They have been already described under the names of pigeon

[1] "Pejorante passione thorax etiam extantior fiet." Caelius Aurelianus : Acut. morb. lib. ii. cap. 27, ¶ 144.

breast, cupping of the lower part of the chest in front, and bulging of the upper part of the chest in front.

§ III. i. Œdema of the lungs, blood and diphtheritic exudations in the air-tubes, and miliary tuberculosis, cannot be distinguished from simple catarrh by the physical signs alone. ii. Pneumothorax is simulated when the main bronchus of a lung is completely plugged by mucus; an accident sometimes met with in the stupor of cerebral diseases, sometimes occurring rather suddenly in the course of simple bronchitis.[1] The breath-sound is suppressed over the greater part or the whole of one side, and the percussion-note is clear. But the displaced mediastinum and amphoric signs of pneumothorax are wanting. iii. Plugging of a main bronchus by anything but mucus is usually a severer condition: the signs being the same, the diagnosis depends on other circumstances.[2] iv. The rale of pleurisy is sometimes mistaken for a simple catarrhal rale: pleuritic rale however is mostly unilateral.

[1] Watson: Lectures on the principles and practice of physic: 4th edit. vol. ii. p. 37. 1857.

[2] See chapter ix.

CHAPTER II.

PULMONARY ŒDEMA.

THE simplest kind of pulmonary œdema is that which occurs acutely in the course of renal dropsy: it is to this form of œdema that the following remarks especially apply. The other kinds of œdema of the lungs are usually more or less complicated with other pulmonary lesions, such as the chronic bronchitis and brown induration of cardiac dropsy.

§ I. The physical signs of pulmonary œdema are due to the presence of a large quantity of thin liquid in the air-passages.

¶ I. The respiratory sound is hidden by the rales. Bronchial breathing sometimes is heard in compact œdema, apart from any compression of the lung by hydrothorax.

¶ II. Mucous rales, small in size, often sharp and reverberating. True crepitation, either in patches here and there, or much more extensive so as to involve the whole of one or both lungs, is sometimes present.

§ II. i. Pulmonary œdema is always bilateral sooner or later, but it may attack one lung some hours before the other. ii. Hydrothorax is a complication almost constant; and also bilateral, unless obliteration of one pleural cavity by adhesion render the effusion necessarily unilateral. iii. Great inspiratory dyspnœa is sometimes present; attended, it may be, by extreme recession of the infra-mammary regions, even when there is hydrothorax also. iv. Percussion note unaffected: or somewhat diminished in resonance: or unnaturally clear in patches, where the subjacent lung happens to be relaxed in consequence of the œdema or hydrothorax. Dulness to percussion, at the bases of the chest, in proportion to the hydrothorax. v. Dilatation and pulsation of the jugular veins may sometimes be seen.

§ III. The diagnosis of pulmonary œdema from pulmonary catarrh depends more upon the symptoms than upon the physical signs.

CHAPTER III.

PULMONARY CONGESTION.

§ I. The only physical sign supposed to indicate simple pulmonary congestion consists in accentuation of the cardiac second sound over the pulmonary artery; in other words, the pulmonary second sound is louder than the aortic. Great importance has been attributed to this sign by some physicians. In simple congestion of the lungs the pulmonary sigmoids ought, no doubt, to be shut with greater force than the aortic. But the evidence which auscultation has been supposed to give of increased pulmonary tension is, as Andrew has shown, fallacious.[1] For greater loudness of the pulmonary second sound may be merely relative, and due to weakness of the aortic sound: or the pulmonary sound may be conducted better than the aortic: or, again, a pulmonary sound, which is really

[1] On the diagnosis of systolic endocardial murmurs, whose point of greatest intensity is at or near the left apex of the heart. St. Bart. Hosp. Reports, vol. i. p. 13. 1865.

accentuated, may seem not to be so, because conducted badly.

§ II. Passive pulmonary congestion is almost necessarily associated with catarrh and its physical signs. Other complications, also common, are collapse, œdema, hydrothorax, and hæmorrhagic infarctus.

§ III. Brown induration of the lungs is a consequence of chronic congestion. Some impairment of the percussion resonance, especially over the lower lobes and on the left side, is the only sign relative to this lesion.

CHAPTER IV.

PULMONARY HÆMORRHAGE

§ I. The physical signs of a moderate bronchial hæmorrhage are simply rales due to the presence of blood in the tubes: when the blood is expectorated as fast as poured out, there will not even be rales.

§ II. Hæmorrhagic consolidation of the lung, when extensive enough (not less than three inches in diameter at the surface) yields the physical signs which would be expected, namely, dulness to percussion and bronchial breathing. Hæmorrhagic infarctus is usually complicated by chronic catarrh and congestion, with their consequences.

CHAPTER V.

PULMONARY EMPHYSEMA.

BY pulmonary emphysema is meant a progressive dilatation of the air-sacs and destruction of their septa, associated with increase in the bulk of the lung—hypertrophous emphysema.

§ I. The signs indicate enlargement of both lungs. i. Bilateral enlargement of the thorax. ii. Depression of the diaphragm, involving depression of the heart, liver, spleen, and stomach: epigastric pulsation is a very early sign. iii. Extension of the lung in front of the heart: whereby the area of superficial cardiac dulness is diminished or abolished, and the heart's impulse and sounds become enfeebled. iv. Bulging of the lungs above the clavicles, especially during cough or powerful expiration.

§ II. i. Emphysema is always bilateral, unless there be a lesion of one lung such as to forbid its expansion. When one lung is indurated, or greatly collapsed from unyielding pleural adhe-

sions, it is common to find emphysema of the other lung. ii. The respiratory movements tend to assume the characters described under the name of non-expansive inspiration and expiratory dyspnœa. iii. The percussion-note tends to fall in pitch, that is to say, to become tympanitic; the muffling mostly remains unchanged, or is even increased, although sometimes the note becomes clear in places. iv. The respiratory sound is usually weakened, in consequence of the non-expansive inspiration. And the expiratory sound is often greatly prolonged, in consequence of the expiratory dyspnœa. v. Friction sound is occasionally produced by distended subpleural sacculi. vi. A muscular rumble is sometimes heard over the chest. vii. Emphysema is often associated with pulmonary catarrh, and the physical signs are modified accordingly. Dilatation of the heart is a necessary consequence of long-standing emphysema.

§ III. Emphysema has been confounded with pneumothorax. But bilateral pneumothorax is incompatible with life, and emphysema is bilateral. Moreover, amphoric signs are never present in emphysema.

CHAPTER VI.

PULMONARY ATROPHY.

ATROPHY of the lungs, with enlarged air-sacs, occurs as a part of general senile atrophy, or as a consequence of previous pulmonary disease, especially arrested phthisis.

§ I. There are no physical signs essentially belonging to the lesion.

§ II. Its accidental characters are these: i. Shape of chest uncertain, except that it is not bilaterally enlarged. ii. But it has all the fixed and inexpansible look of emphysema; the sterno-mastoid muscles stand out strongly against the sunken supra-clavicular spaces, unless they be bulged by a forcible expiration. iii. Diaphragm depressed; epigastric pulsation. iv. Heart covered by lung. v. Tympanitic percussion note over front of chest: the note is less resonant behind. vi. Signs of catarrh are common.

§ III. To these characters add the negative condition, that there are no definite signs of other disease (excepting those perhaps of arrested

phthisis); and we have all the conditions which render a physical diagnosis of pulmonary atrophy possible in a patient whose symptoms point to disease of the lungs.

CHAPTER VII.

ASTHMA.

BY asthma is meant recurrent fits of dyspnœa, whereof the condition originally lies in the nervous system.

§ I. The physical signs proper to asthma; or, in other words, the signs of an asthmatic paroxysm. i. Expiratory dyspnœa; expiration forced and greatly prolonged; lower parts of chest fixed and altogether immoveable; no abdominal movements of respiration, or hardly any: this immobility of the chest, in spite of powerful efforts at breathing, is very characteristic. ii. Chest bilaterally dilated during the paroxysm: diaphragm depressed. iii. Breath sounds weakened, sometimes almost inaudible. iv. Sonorous and sibilant rales common: mucous rales also towards the end of the attack. v. Heart sounds very weak and muffled.

§ II. In the intervals of the paroxysm, the patient usually affords signs of pulmonary emphysema, atrophy, or catarrh.

CHAPTER VIII.

PULMONARY COLLAPSE.

§ I. Collapse of a few vesicles is indicated when deep inspiration brings out a crepitant rale, audible for a few breaths only, and then heard no more for a time: a sign common at the base of the lung, back or front.

§ II. Collapse of larger portions of lung requires, for diagnosis, two conditions, namely, that the lesion be extensive, and that the collapsed lung be in contact with the chest wall.

¶ I. Extensive collapse of this kind sometimes occurs acutely. A lesion most common in young children, and especially in children feeble or rickety, and suffering from pulmonary catarrh, hooping cough, or disease of the brain. The signs are much the same as those of sudden plugging of a large bronchus,[1] and are dependent upon the solidified and contracted lung. i. The base or even the whole of one side of the chest is shrunken. ii. The movements on the

[1] See chapter ix.

same side much impaired. iii. Dulness to percussion over the collapsed part: and sometimes a tracheal note in the parts around. iv. When the front of the left lung is collapsed, the heart is uncovered, and its area of percussion dulness increased. When the left lower lobe is collapsed, the heart is displaced to the left. When the right lower lobe is collapsed, the heart is displaced to the right, and the liver rises. v. Bronchial breathing over the area of dulness. vi. Rales are usually present; and will be quite gurgling in character, if the collapse surround large tubes, such as those at the root of the lung.

¶ II. Extensive collapse may be developed more gradually. i. The conditions and the signs are sometimes the same as those of the acute collapse just described. ii. In typhoid fever we meet with signs, due to simple temporary collapse, but which, when discovered in a patient examined for the first time, may be thought due to phthisis.[1] These are dulness to percussion at one apex, weak or puerile breathing there, and universal sonorous or mucous rales. These signs last not more than a day or two.

[1] S. Gee: Remarks upon typhoid fever. St. Bart. Hosp. Reports, vol x. p. 13. 1874.

iii. Collapse of the right lower lobe is sometimes dependent upon great enlargement of the liver: collapse of the left lower lobe sometimes occurs in dilated heart or pericardial effusion. The diagnosis from pleural effusion depends upon the result of puncturing the chest. iv. Upon very chronic collapse, grey induration slowly supervenes.[1] The signs are those of consolidated and shrunken lung: local retraction of the chest wall, impaired resonance to percussion, bronchial breathing, and haply signs of catarrh or dilated bronchi. The diagnosis from phthisis depends greatly upon the whole history of the case. v. Absorption of pleural effusion sometimes leaves the lung adherent to the chest wall and permanently collapsed; a state which will be discussed in the chapter upon Adherent Pleura.

[1] Thomas Addison: A collection of his published writings, p. 28. New Sydenham Society. 1868.

CHAPTER IX.

PLUGGING OF TRACHEA OR BRONCHUS.

THE trachea or a large bronchial tube may be plugged by a foreign body which has entered through the glottis or through a fistulous opening in the windpipe. The trachea bifurcates on a level with the angulus Ludovici and the third dorsal spine. The spur which separates the bronchi is to the left of the middle line, and this is the chief reason why foreign bodies fall into the right bronchus more often than into the left.

§ I. The signs of the obstruction are these :—i. Inspiratory dyspnœa, attended by imperfect movements of the chest walls, on one or both sides, according to the seat of the obstruction. Inspiratory recession of the base of the chest may involve both sides, even when one bronchus only is obstructed.[1] ii. Percussion note not much affected. iii. Respiratory sounds weakened,

[1] S. Gee : Foreign bodies in the air passages. St. Bart. Hosp. Reports, vol. xvi. p. 53. 1880. Also St. Bart. Hosp. museum : specimen no. 1681a

haply almost abolished, over the parts involved. iv. A whistling sound or rale (rhonchus, sibilus, stridor), inspiratory and expiratory, produced at the seat of obstruction, the plugging being incomplete. The rale is usually loud, and heard over a great extent of chest: the seat of the obstruction is not necessarily nearest to the spot where the rale is heard loudest. v. A palpable thrill, due to the same vibration as the rale; inspiratory or expiratory; felt over one side or both.

§ II. Permanent plugging of a bronchus is followed first by collapse, and afterwards by dilated tubes, and destructive pneumonia. The physical signs are these:—i. Permanent recession of the chest wall is common; when it is unilateral, the other side is sometimes distended. Yet the shape of the chest is not always altered; it is in a few cases quite natural. ii. Percussion note over the affected part much impaired. iii. The auscultation signs depend greatly upon the degree of bronchial obstruction; sometimes there is little or no breathing sound; sometimes there are bronchial or cavernous breathing, and rales more or less reverberating. Further details will be found in the chapters on Pulmonary Collapse and on Destructive Pneumonia.

CHAPTER X.

PLEURISY.

ALTHOUGH pleurisy cannot exist without inflammatory effusion, yet the term, pleurisy with effusion, is applied to those cases only which are attended by liquid effusion; these will be discussed hereafter. In the present place I purpose to treat of pleurisy attended by effusion of coagulable lymph.

§ I. Pleurisy of this kind is often very local. The sign, not always present, is local friction sound. The resonance of the affected part of the chest may or may not be somewhat impaired.

§ II. Pleurisy of this kind is sometimes universal, involving the whole of one pleura. i. The affected side is retracted, it may be considerably, and moves much less freely than in health. ii. The percussion-note is raised in pitch and muffled, over the greater part or the whole of the side. The sense of resistence is

increased. When the disease affects the left side, the superficial area of cardiac dulness is extended. iii. The respiration generally is weak, and attended by friction sound (especially in the complemental space), or by wide-spread rale, indistinguishable from the mucous rale of catarrh or phthisis.[1] At places the breath-sound may be bronchial, in all degrees of intensity, up to a hollow resonance, such as Laennec himself would have supposed to leave no doubt of cavity.[2] iv. Add to the physical signs hectic fever, and we cease to wonder that pleurisy of this kind is usually mistaken for phthisis more or less advanced. However, the pleuritic patients recover completely, without a vestige of disease left behind, save haply a slight unilateral retraction of the chest, or a cuplike depression. Whenever the signs of a case of supposed phthisis are in some respects peculiar; whenever they indicate advanced disease limited to one side of the chest; whenever cavernous signs are heard in unusual places; it is well to

[1] Thomas Addison: Works, p. 88.

Trousseau: De la pleurésie; Clinique médicale, vol. i. p. 610: 2nd edit. 1865.

[2] I have heard this pleuritic cavernous breathing most often near and below the right nipple.

weigh the possibility of simple pleurisy. The most useful guide to physical diagnosis is this, that, as a rule, the signs of pleurisy are more marked in the lowermost part of the chest, and that the signs of phthisis are more marked at the upper part.

CHAPTER XI.

PLEURAL EFFUSION.

THE different kinds of fluid effusion into the pleura may be thus classified:—

1st.	Gaseous	. . .	Pneumothorax.
2nd.	Liquid :	i. dropsical .	Hydrothorax.
		ii. inflammatory	Pleurisy with effusion.
		iii. blood . .	Hæmothorax.
3rd.	Food and drink.		

The effusion is either unilateral or bilateral: either total (filling the whole of the pleural cavity) or partial: and a partial effusion is either loculated (enclosed in adhesions) or free. The lung collapses in a degree proportionate to the abundance of the effusion. Wherefore total pleural effusion is always unilateral, inasmuch as collapse of both lungs is obviously incompatible with life.

With reference to the third kind of pleural effusion, no more need be said than that it is very uncommon, that it is due to a rupture of

the œsophagus near to the stomach, that vomiting is the usual cause of the rupture, and that the signs would probably be those of hydropneumothorax.[1]

[1] Atrocis, nec descripti prius, morbi historia. Secundum medicae artis leges conscripta ab Hermanno Boerhaave. Lugd. Batav. 1724. See St. Bart. Hosp. museum : specimen no. 1863.

CHAPTER XII.

PNEUMOTHORAX.

THE varieties of pneumothorax are these :—

1st. Air and liquid present in the cavity :
  i. Cavity large :
    a. closed . . . . . Hydro-pneumothorax.
    β. with an external fistula . Fistulous Empyema.
  ii. Cavity small . . . . . Loculated Pneumothorax.
2nd. Air alone present in the cavity . Pure Pneumothorax.

Art. I.—Closed Hydropneumothorax.

§ I. Its physical signs are these :—Unilateral distension of the chest, tympanitic percussion sound, enfeebled respiration and amphoric phænomena.

¶ I. Distension of the chest is indicated by :—i. Unilateral enlargement ; sometimes so great as to cause an excess of three inches in the semi-circumference on the affected side. ii. Depres-

sion of the diaphragm ; sometimes so great as to force the upper surface of the liver altogether below the level of the costal margin in front, and to produce a band of tympanic resonance in the abdomen, above the liver dulness. iii. Displacement of the mediastinum towards the unaffected side occurs almost instantaneously in perforative pneumothorax ; at first due no doubt to traction exerted by the lung which is not collapsed ; but before long the air in the pneumothorax comes to exert positive pressure upon the mediastinum.[1]

¶ II. The percussion-sound falls in pitch and increases in duration, that is to say, becomes tympanitic in proportion to the distension of the pleura. The note, however, remains muffled ; and, in fact, when the distension is extreme, the muffling approaches dulness. Amphoric quality is sometimes possessed by the percussion note, sometimes not. Where liquid is present, non-resonance will be found : the liquid effusion is free, moveable, and changes its position with change in the position of the body.

¶ III. The respiratory sound is weakened in proportion to the collapse of the lung. Sometimes the collapse is so complete, that no breath-

[1] See page 193.

ing is audible, except in the vertebral groove. When the lung has been much solidified by previous disease, so that collapse can hardly ensue, a respiratory sound, more or less loud and bronchial or amphoric, will be heard all over the pneumothorax.

¶ IV. Amphoric signs, indicative of a large cavity are present. But puncture of the pleura, even when it does no more than make the pressure equal within and without the chest, the pneumothorax remaining, will sometimes remove amphoric hum and bell-sound for a time. i. Amphoric hum attends the sounds of breathing, coughing, or talking. And let it not be supposed that amphoric respiration is necessarily due to air passing freely out of the lung into the pleural cavity and back again: on the contrary, this is seldom the case; the breath sounds heard are pulmonary sounds, and acquire their amphoric quality by transmission through the pneumothorax. ii. Metallic tinkling may be present. iii. The bell-sound is a very important sign of a large pneumothorax. iv. Succussion splash occurs when the quantity of liquid is considerable.

§ II. The inspiratory movement of the affected side is non-expansive: the vocal thrill

is diminished, or even abolished. The respiration on the unaffected side is puerile. When the pneumothorax is secondary to phthisis, the apex of the lung often remains adherent. In an old pneumothorax a large ulcerous opening is sometimes formed between the cavity and a large air-tube: thereupon, all active distension of the side ceases. In rare cases air is effused into the pericardium as well as into the pleura, whereby the signs indicative of a displaced mediastinum are lost.

Art. II.—Fistulous Empyema:

Differs from a closed hydropneumothorax in that the affected side is distended very slightly, or not at all, or more frequently is contracted. Consequently the signs due to a large air-containing cavity are seldom present. The sound of lung-shock is occasionally produced in a fistulous empyema.

Art. III.—Loculated Pneumothorax:

Is not common; when associated, as it often is, with a permanent pulmonary fistula, the diagnosis from a cavity formed within the lung becomes difficult, or impossible.

Art. IV.—Pure Pneumothorax:

Is an uncommon lesion, mostly of traumatic origin. The physical signs are the same as those of a closed hydropneumothorax, excepting such as are due to the presence of liquid.

Traumatic rupture of the diaphragm, on the left side, is apt to be followed by a state of things which has been mistaken, during life, for pneumothorax.[1] The stomach and colon pass up into the pleural sac; they become greatly distended with gas; the lung collapses. Hence displacement of the mediastinum, such that the heart beats to the right of the sternum; tympanitic percussion note over nearly the whole of the left side: and great weakening or abolition of the breathing sounds there. The bell sound would probably, the metallic tinkle and succussion splash might possibly, be present. Enough, in this place, to have pointed out the necessity of a cautious diagnosis.

[1] Butlin: Notes of three cases of air in the cavity of the pleura, as the result of injury. St. Bartholomew's Hospital Reports, vol. xi. p. 255. 1875.

Congenital deficiency of half the diaphragm produces similar results: see Polaillon, Union Médicale, no. 97 1881.

An abscess below the diaphragm may become partly filled with air, and may so raise the diaphragm, the pleura remaining uninjured, as to give a tympanitic percussion note over the lower part of the chest, but not the amphoric signs of pneumothorax.[1] More commonly such abscesses are accompanied by thoracic empyema, the diaphragm being perforated or not; if perforated, there is a pyopneumothorax also.[2]

[1] Eisenlohr: Zwei Fälle von lufthaltigen Abscessen zwischen Diaphragma und Leber. Berlin. klin. Wochenschrift. Sept. 1877, p. 539.

[2] Leyden: Ueber Pyopneumothorax subphrenicus. Ibid. Nov. 3, 1879.

CHAPTER XIII.

HYDROTHORAX.

HYDROTHORAX and œdema of the lungs, pleural and pulmonary dropsy, often co-exist. A serous effusion due to pleurisy sometimes obtains the name of hydrothorax; but the word is used in this place to signify a simple dropsy. Hydrothorax tends to be bilateral, although on account of local conditions, the quantity of effusion is not always equal on both sides. And, being bilateral, the fluid cannot occupy more than a portion of the pleural cavities, the effusion is partial.

i. When pulmonary œdema also is present, it is possible for great inspiratory dyspnœa, such as to simulate laryngeal obstruction, to concur with copious hydrothorax. ii. The diaphragm is depressed: the base of the thorax expanded: the position of the mediastinum remains unchanged. iii. Dulness to percussion co-extensive

with the effusion. iv. Respiratory sound and vocal resonance either simply weak or feebly bronchial, over the regions where the percussion note is dull : sometimes a little mucous rale. In cases of general anasarca in the adult, it is not possible to detect an effusion much less in quantity than half a pint in each pleura.

CHAPTER XIV.

PLEURISY WITH EFFUSION.

PLEURISY with effusion is usually unilateral.

The course of pleurisy may be divided into periods of increase, height, and decline.

§ I. Period of increase.

¶ I. Sometimes friction sound is the earliest sign of pleurisy with effusion. Or, instead of friction sound, pleuritic rale (page 221), may be heard over the whole of one side of the back. The primitive friction is usually much more local: its common situation being over the base of the lung, in front or at the side; that is to say, over the complemental space of the pleura (page 190).

¶ II. More frequently, however, the earliest signs are those of liquid effusion: the same signs speedily supersede any friction sound or pleuritic rale which may have preceded them. The liquid tends to collect, as soon as formed, in the lowest place. At first, when the quantity is small, the lung is simply relaxed, and swims

upon the effusion: but as the liquid accumulates it compresses the lung, and renders it more or less empty of air. i. The great sign of liquid effusion is a co-extensive dulness to percussion. This dulness is not wholly due to the effusion, but is partly dependent upon associated collapse; that is to say, a layer of liquid an inch or more thick would transmit percussion resonance of the lung, were the lung resonant (page 96). The dulness begins at the lowest part of the chest behind; the note being natural elsewhere. When the effusion rises higher than the angle of the scapula, the lung will have relaxed to such an extent as to give a clear subtympanitic or tracheal note above the nipple of the same side in front: a sign not always present even in cases watched day by day from the onset. Whether, by further increase in the quantity of the fluid, the whole back become dull before the front is so at all, or whether the upper level of the fluid be comparatively horizontal, depends upon this circumstance, namely, whether the patient took to his bed early in the disease, or whether he kept about while the effusion was going on. So that, when the effusion is small, the dulness may be wholly posterior, and sharply defined in front by the posterior

axillary line, the lateral region remaining entirely resonant. On the other hand, the upper limit of dulness, when it occupies the lower and not the hinder part of the chest, often rises higher in the axillary region than in the back.[1] Even when absolute dulness is confined to the base, there is usually some impairment of resonance all over the back on that side. The level of dulness is always higher behind than before. The line of demarcation between resonance and non-resonance is sharper before than behind. The dulness over the effusion may be far from absolute. The anterior clear resonance, when present, is sometimes of cracked-pot quality. ii. In proportion to the amount of effusion, the side is enlarged, diaphragm depressed, and mediastinum displaced. Yet even this rule is not constant: the heart may remain unmoved by an effusion of not less than a quart of serum. iii. The vocal thrill is diminished where dulness to percussion exists, and is wholly abolished in great distension of the side. iv. The respiration is at first weakly vesicular, and sometimes remains so throughout the disease. But mostly the breathing soon becomes bronchial; sometimes even before the

[1] Garland: Pneumono-dynamics. New York, 1875.

dulness becomes absolute. With progressive increase of effusion, the bronchial breathing tends to become less and less loud until, at last, it is wholly suppressed. But sometimes, although the quantity of fluid be very great, loud bronchial breathing is heard all over the affected side: the fact being that the loudness depends, not inversely upon the quantity of fluid effused, but directly upon the openness of the air-tubes.[1] v. Vocal resonance weak and bronchial in much the same manner as the respiratory sound.[2] When the effusion is partial, with clear resonance in front, the bronchophony is sometimes ægophonic about the angle of the scapula.

§ II. The effusion at length reaches its height. This sometimes will not be until the pleural cavity is tensely full; or the effusion may stop at any point short of that extreme. When the quantity of fluid on the left side is very great, the left half of the diaphragm is occasionally

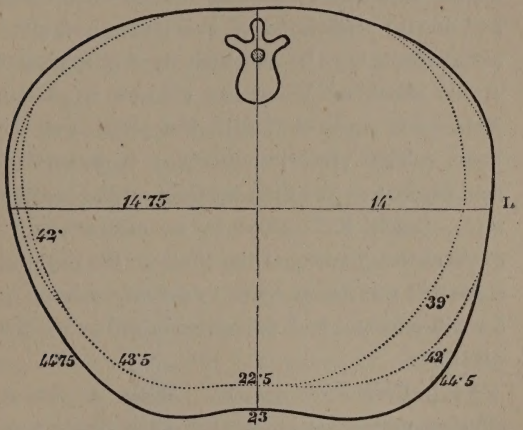
[1] Thomas Addison: Works, p. 73.

Landouzy: Nouvelles données sur le diagnostic de la pleurésie et les indications de la thoracentèse. Archives générales de médecine: series v. vol. viii. p. 513. 1856. He gives the references to Rilliet and Barthez, Béhier, and other French writers on this topic.

[2] With Baccelli's doctrine concerning the transmission of whispering I utterly disagree.

depressed to such an extent that not only can the lower margin of the spleen be felt, but even its

Fig. 18.



COURSE OF PLEURISY WITH EFFUSION, LEFT SIDE.
Outer line — horizontal section before paracentesis.
Middle line (dotted) — four days after paracentesis.
Inner line (dotted) — three weeks after paracentesis.

upper margin, in fact its whole circumference. And at the same time, the thrusting of the heart and mediastinum over into the right side of the thorax may cause the right wing also of the diaphragm to be depressed to an almost equal degree; a point ascertained by examination of the liver. Percussion, moreover, may

show that the liquid reaches beyond the edge of the sternum on the other side of the chest. A small protrusion, in the lateral region, distended during expiration, receding during inspiration, and due to perforation of the pleura and intercostal space, may be met with, even in moderate serous effusion. When the effusion is partial, it does not easily shift with the position of the body. The semi-circumference is sometimes actually less on the diseased than on the healthy side. Lastly, it is often by no means easy to guess at the quantity of the effusion: the physical signs will sometimes seem to indicate a large or a small effusion, and paracentesis will prove the contrary.

§ III. Period of decline. When a pleural effusion undergoes absorption, or is discharged by paracentesis, the following series of physical signs are noted.

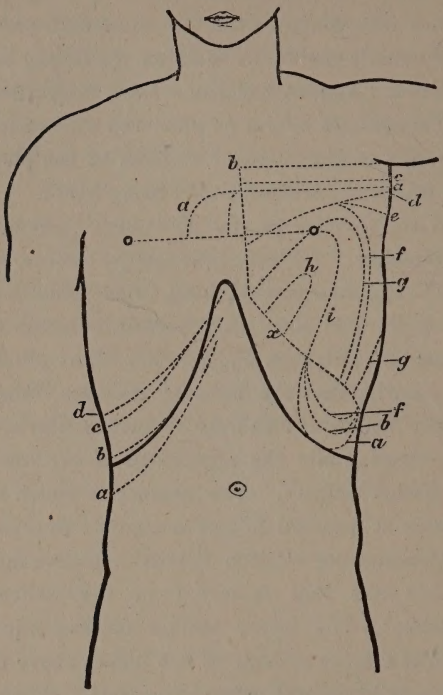
The diaphragm and mediastinum go back towards their natural position: to follow the retreating organs is the best means of marking the progress of absorption, so long as the quantity of the effusion remains great. The distension of the affected side becomes less; and accurately to register this fact is a most important service rendered by the cyrtometer. When the effu-

sion has so far diminished that the lung again comes into contact with the chest-wall, percussion usually enables us to follow the falling level of fluid. And, at the same time, auscultation will sometimes inform us when and where actual adhesion of the opposed surfaces of the pleura has occurred; friction sound being heard.

With reference to the percussion signs more particularly. Dulness, practically absolute, and due to the unexpanded lung, often remains for a considerable time after perfect adhesion has occurred. This fact, and another before alluded to, namely, that the limit of absolute dulness cannot be always sharply defined posteriorly, sometimes render the attainment of our aim in percussion difficult. The manner in which the effusion is absorbed is not constant: as a rule, the diminishing effusion follows a course more or less like that indicated in the annexed sketches.[1] The upper surface of the liquid, when it reaches as high as two inches above the nipple, is horizontal: when lower than this point, the dulness forms irregular parabolic curves, which become smaller and smaller, and last of

[1] Damoiseau: Recherches cliniques sur plusieurs points du diagnostic des épanchements pleurétiques. Arch. gén. de Med., series iv. vol. iii. p. 129. Oct. 1843.

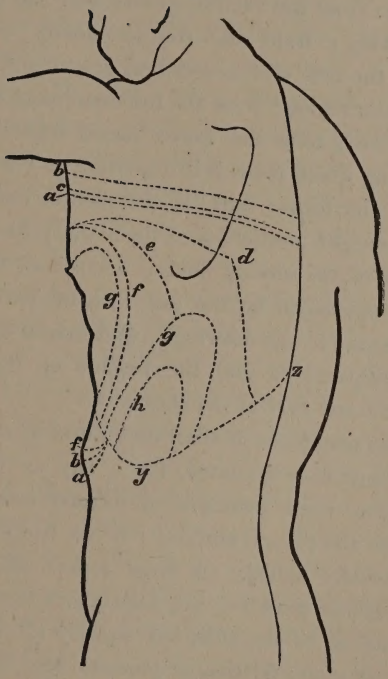
Fig. 19.



THE COURSE OF AN EFFUSION INTO THE LEFT PLEURA: FROM DAMOISEAU.

a a = limits of effusion, heart, liver, and spleen, when patient first seen.
b b = same on first day of treatment. *c c* = second day.
d d = third day. *e e* = fourth day.
f f = fifth day. *g g* = morning of sixth day.
i = evening of sixth day.
h h = last limits of effusion previous to disappearance, *i. e.*, on tenth day.
x y z = lower limit of pleura.

Fig. 20.



COURSE OF AN EFFUSION INTO THE LEFT PLEURA: FROM DAMOISEAU.

all disappear at the lowest parts of the thorax. The fluid is mostly absorbed in the following order: from the vertical groove near the root of the lung; from the supramammary region; from the rest of the vertebral groove and infra-scapular region; from the inframammary region, and lastly from the lower lateral region; concerning which point it is important to remember that the lowest part of the pleural cavity, in the upright position, is in the axillary line. The curve of the sinking fluid is sometimes double, as happened to be the case with the patient represented in the drawing. And indeed we must be prepared to find the residue of liquid in almost any part of the chest.

Disappearance of absolute dulness at any spot is sometimes attended, for a day or two, by friction sound, indicative of restored contact between the pleural surfaces: redux friction, as it is usually called. A large serous effusion is sometimes absorbed, not from above downwards according to the rule, but equally all over the side at once; friction or pleuritic rale becoming audible all over the side at once.

The latest physical sign, dependent upon absorption, is the retraction of the affected side. Cup-like sinking of the lower part of the sternum

occasionally ensues. In some cases these deformities tend to disappear gradually, in others they are permanent. The displacement of the heart sometimes continues after the absorption is complete.

§ IV. The Diagnosis. The crucial test of pleural effusion consists in puncture of the chest, as before described. When pus is very thick, it cannot be drawn through a fine needle: in this case a larger aspirating trocar and cannula must be used. The false membranes around an old empyema are sometimes extraordinarily thick and tough: when the needle is felt to enter tissue of this kind, it must be pushed on boldly, and pus will almost certainly be reached. i. Cancer of the lung closely resembles pleural effusion in respect of the physical signs. But cancer does not often cause enlargement of the affected side: nor does the dulness of cancer usually follow the laws which have been laid down with regard to pleural effusion. ii. Quickly-growing sarcoma, within a pleural cavity, has been known to distend the side of the chest, to displace the heart and diaphragm, and altogether to simulate large pleural effusion, except in the results of puncture.[1] iii. Hydatid tumours within the

[1] De Havilland Hall: A case of intrathoracic sarcoma. Clinical Soc. Trans. vol. xiii. p. 200. 1880.

chest are not common: their characters will be described hereafter. iv. Chronic collapse and induration of one lung, in whole or in part, has been mistaken for pleural effusion. The case of collapse of a whole lung will be discussed in the chapter on Adherent Pleura. The collapse of the lower lobe of the left lung, which depends upon dilatation of the heart or pericardial effusion, is not easily distinguished from a moderate pleural effusion, except by puncture. v. Acute pneumonia is seldom confounded with pleural effusion unless the tubes of the pneumonic lung be plugged with mucus, so that conduction of the breathing sounds is obstructed. But acute pleurisy with effusion is often wrongly supposed to be pneumonia. Much weight must be allowed to the fact that pleurisy with effusion tends to enlarge the chest, alter its shape, and displace the diaphragm and mediastinum; and that pneumonia does not. vi. But with chronic induration, destructive pneumonia and phthisis of the lower lobe it is very different: the diagnosis of these lesions from a chronic loculated pleural effusion is often impossible except by puncture. And even in puncture may lurk a fallacy already alluded to, namely, that the needle may draw off a small quantity of pus from a phthisical cavity.

vii. Hepatic tumours, especially hydatids and abscesses, sometimes reach so high in the chest as closely to simulate pleural effusion on the right side. The clue to diagnosis lies in the detection of hepatic enlargement by abdominal examination, and in the results of puncture. viii. To distinguish an abscess situated between the liver and the diaphragm is impossible, unless the abscess point below the costal margin. Indeed both hepatic and sub-diaphragmatic abscesses are often complicated with loculated empyema at the base of the right chest. And in several complicated cases of this kind I have known the trocar to pass right through the empyema and diaphragm into the abdominal abscess: the diaphragm lying high in the chest in spite of the empyema.[1] ix. Densely coagulated hæmothorax has been mistaken for empyema.[2]

[1] Irvine: On a case of co-existing abscess of liver and empyema. Clinical Soc. Trans. vol. x. p. 174. 1877.

[2] Watson: Principles and practice of physic: 4th edit. vol. ii. p. 117. 1857.

CHAPTER XV.

EMPYEMA.

§ I. An empyema of the whole of one pleural cavity affords the physical signs which have been described under the head of pleurisy with effusion. Often enough the distension of the affected side is anything but great: the heart for instance may be scarcely at all displaced, a fact which is sometimes due to pleural adhesion over the pericardium. The signs of pneumo-empyema (pyopneumothorax) and of fistulous empyema have been already described.

§ II. Small collections of pus in the pleura are sometimes enclosed in dense adhesions: loculated empyemata.

¶ I. These partial empyemata occur in the following situations: i. Most commonly in the back of the pleural cavity, or between the lung and the diaphragm: the latter, or diaphragmatic empyemata, are usually larger behind than in front. ii. Less commonly in the lateral region, in the anterior region, and between the lung and

pericardium. iii. Sometimes there are many small empyemata in one pleural cavity: sometimes there is a loculated empyema on each side.

¶ II. These empyemata are often complicated: when diaphragmatic, with subdiaphragmatic and hepatic abscess: when on the left side, with purulent pericarditis. An empyema on the right side of a person who has lived in the tropics, and who has suffered from dysentery or hepatitis, is very often associated with deep abscess of the liver.

¶ III. The physical signs are these. i. Chest contracted on the affected side; or contracted above and distended below; or there may be a local bulging; in the axillary region, bulging is common. ii. Breathing movements of the pleuritic side diminished. A pointing empyema sometimes moves with breathing, bulging with expiration and falling with inspiration. iii. Heart sometimes displaced, often not. Liver sometimes displaced downwards in diaphragmatic empyema: however, even in a large diaphragmatic empyema on the right side, the liver may be not depressed. Stomach note, when the left side is affected, often reaches high, say to the nipple level. iv. Percussion note some-

times impaired over whole of affected side, sometimes not. When the empyema is superficial, dulness at the spot: but not always absolute dulness, the tone of underlying or neighbouring lung being conducted by the effusion. Indeed over very small empyemata (say about an ounce) there is sometimes no dulness at all. The dulness, not being due to the pleural effusion simply (as before explained), affords no criterion of the extent and capacity of the empyema: dulness, absolute and almost universal, may be associated with a small empyema, the signs being chiefly due to collapsed and adherent lung. v. Respiration usually simply weak all over the affected side: sometimes bronchial where the empyema is superficial. Crackling rales are common.

¶ IV. The diagnosis has been discussed in the last chapter. When empyema is complicated with catarrh, the resemblance to tuberculosis, local or general, is great.

§ III. Pulsating empyema means an empyema which pulsates rhythmically with the heart.[1]

[1] The first record of a pulsating empyema is found in Baillou: Epidemiorum et ephemeridum liber secundus: constitutio hiemalis anni dom. 1576. Opp. edit. 1734, Venetiis, vol. i. p. 128. "Filia venerabilis Colettæ," etc.

¶ I. The empyema is commonly very large, occupies and fills the left pleural cavity. i. In a few cases, the pleural effusion (usually purulent, seldom serous) nowhere points or bulges through the chest wall. The pulsations are sometimes seen and felt over almost the whole of the side, but mostly they are limited to the normal heart region (that is to say, on the left of the sternum) or to the lowest three or four left interspaces. ii. More commonly (in more than three-quarters of the whole number of pulsating empyemata) the empyema points in one or two places, which alone pulsate. This bulging occurs in the normal heart region, or in the lowest interspaces: twice has the protrusion been seen in the loin below the ribs. The bulging is never larger than an orange.

¶ II. In all cases of this kind, whether bulging or not, the heart is much displaced to the right: pericarditis may concur, but usually the heart is healthy. Auscultation of the pulsating part may detect conducted heart sounds, but no

A pulsating swelling, about the left breast, which was thought to be an aneurysm, until it burst and discharged pus.

Comby: De l'empyème pulsatile: Paris, 1882: has collected nearly all the recorded instances of pulsating empyema, twenty in number.

murmur. Palpation detects no thrill and no sense of expansion.

¶ III. Paracentesis greatly helps the diagnosis. By removing part of the liquid the pulsation ceases : but the heart does not return to its natural position, being fixed by external pericardial adhesions.

¶ IV. The effusion is mostly chronic, and the lung wholly collapsed. Pneumothorax sometimes concurs ; in this case the pulsation is conveyed by the liquid only.

¶ V. The diagnosis is from intrathoracic aneurysm, and from the very uncommon condition of a pulsating cancerous tumour. Aortic aneurysm and pulsating empyema may concur.

¶ VI. Very seldom the empyema does not fill the whole pleural cavity, but is loculated and enclosed in adhesions. This kind of pulsating empyema always bulges, it may be to the right of the sternum, but in close neighbourhood to the heart.

CHAPTER XVI.

ADHERENT PLEURA.

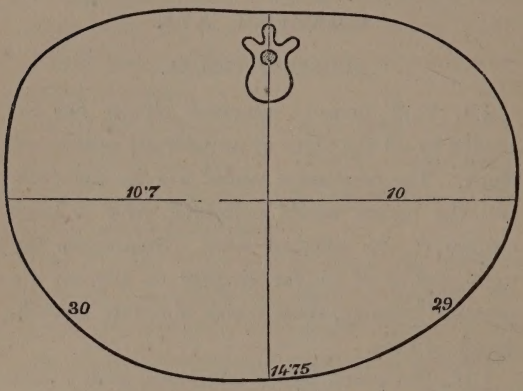
§ I. Very densely adherent pleuræ are attended by all the signs of unilaterally contracted chest. The percussion sound will be deficient, and the breath sound enfeebled, over a large surface of the affected side.[1] Sometimes the signs spoken of in the chapter on pleurisy are present; namely, those which simulate consolidation of lung.

§ II. But much looser adhesions, such as are so often unexpectedly found post mortem, and

[1] Barker has narrated a most unusual form of disease which was probably dependent upon past pleurisy. The right lung was wholly collapsed, and adherent to the chest walls; the mediastinum was displaced so much to the right that the heart lay imbedded, as it were, in the right lung; the diaphragm and liver were raised; the left lung was emphysematous. The physical signs were: fixity of the right side of the chest; heart's impulse impalpable; absolute dulness to percussion over right side; no cardiac dulness; respiratory sounds inaudible on right side. Cases illustrating some difficulties in the diagnosis of pleuritic effusion. Medico-Chir. Trans., vol. xxxiv. p. 131. 1851.

which influence the percussion and auscultation of the chest in no respect, may be sometimes

Fig. 21.



UNILATERAL RETRACTION OF LEFT SIDE OF CHEST CONSEQUENT UPON AN ADHERENT PLEURA.

discovered by the cyrtometer, when one pleura only is obliterated.

§ III. Recovery from pleural effusion or empyema is sometimes complete, so far as physical signs are concerned; the most careful examination failing to discover contraction of the chest, or any other sign of past disease.

CHAPTER XVII.

PNEUMONIA.

ACUTE pneumonia is of two kinds, lobar and lobular; the consolidation being, in the former case massive, and in the latter disseminated.

Art. I.—Lobar Pneumonia.

§ I. The earliest distinctive signs are those which depend upon hepatisation. Of the engorgement, which precedes hepatisation, there are no constant signs. Crepitation certainly is no such sign; for it is a rale which may appear at any period of the disease, and which in many cases does not appear at all: seldom are consolidation-signs preceded by crepitation; and they do not always follow it. Other precursors of the definite signs are met with now and then; mucous rales, and well-marked pleural friction.

The signs of hepatisation sometimes appear quite late in the disease, for instance on the fifth or sixth day of the fever, or even not until

the defervescence. Indeed there may be no physical signs whatever in the course of a disease which resembles pneumonia in all other particulars.

§ II. Hepatisation of the lung is characterised by dulness to percussion, bronchial breathing, and bronchophony. i. In persons whose chest-walls are resilient, the dulness may be less absolute than that afforded by pleural liquid effusion, cancer of the lung, or dense phthisical consolidation. A muffled tubular note sometimes best expresses the character of the percussion sound. When islets of unsolidified lung are imbedded in the surface of the hepatised tissue, they afford the clear resonance of relaxed lung, or even a cracked-pot sound. A cavity, or a large bronchus, separated from the surface by a thin layer of pneumonic lung, will produce the same effects. ii. The bronchial breathing of pneumonia sometimes differs from that commonly met with in other diseases by being more whiffing, tubular in short. However, even in genuine lobar pneumonia, the bronchial breathing is not seldom of the ordinary softer kind. The bronchophony is mostly of the sniffing variety. All breathing sound and vocal resonance may be absent over hepatised lung: this

condition is either fleeting or lasting; when fleeting, it is due to obstruction of the larger tubes by mucus, which a cough can remove; when lasting, the air-passages contain solid exudation or coagula. In infants the bronchophonic cry is often the only auscultation-sign which can be obtained. iii. Nigh unto the area of bronchial breathing and dulness, true crepitation is sometimes heard, over lung whose percussion tone is good, and which may or may not afterwards become dull. Sharp reverberating mucous rales are sometimes present. Friction sounds also. iv. Wintrich [1] and Ziemssen [2] have shown, the former with reference to adults and the latter to children, that, in lobar pneumonia of the lower half of a lung, the chest, on that side, is expanded to the state of deep inspiration. I have already pointed out how much this expansion is less than that of a pleural effusion; moreover, pneumonia never displaces the heart or the diaphragm. v. Pneumonia of the upper part of the lung behind is sometimes attended by the clearest tracheal percussion note in front on the same side. vi. Hepatised lung is sometimes

[1] Einleitung, p. 84.

[2] Pleuritis und Pneumonie im Kindesalter. Berlin, 1862, p. 235.

felt to throb rhythmically with the heart. Laennec[1] believed that the solid lung simply conducted the heart's movements: Graves[2] held that the dilated vessels of the engorged lung pulsate.

§ III. Hepatisation mostly undergoes resolution; which is characterised by progressive diminution in the bronchial quality of the breathing, by the occurrence of mucous rales and by gradual restitution of the pulmonary percussion-note. Abundant true crepitation may be heard during this stage. The percussion-note may become tracheal and clear for a day or two. A considerable degree of impaired resonance often remains for a long time after all the acuteness of the pneumonia has passed away. Occasionally the solidified tissue softens rapidly down into an abscess, a condition which does not admit of diagnosis. Empyema is a sequel not very uncommon.

§ IV. The diagnosis of lobar pneumonia mainly relates to acute pleurisy with effusion. When breathing sounds are not heard over hepatised lung, a pleural effusion is somewhat simulated. Much more often is an acute pleural

[1] Auscult. médiate : 2nd edit. vol. ii. p. 388.
[2] Clinical lectures : 2nd edit. vol. ii. p. 39.

effusion, not very large, supposed to be pneumonia. In either case, if the diagnosis cannot otherwise be attained, a puncture should be made.

Art. II. Lobular Pneumonia.

Severe catarrhal or diphtheritic bronchitis occurring in children, old people, or debilitated persons, is very apt to be accompanied by lobular pneumonia. If the pneumonic foci be discrete, the signs are not more than those due to the catarrh. If the foci be confluent over a considerable extent of lung, dulness to percussion, bronchial breathing, and sharp reverberating rales may be heard: over the middle lobe of the right lung for instance. The pneumonia of measles, which is commonly deemed to be of the lobular kind, certainly sometimes yields all the signs of the lobar disease.

CHAPTER XVIII.

DESTRUCTIVE PNEUMONIA AND PULMONARY GANGRENE.

DESTRUCTIVE pneumonia due to plugging of a bronchus has been already described. There are moreover other, yet similar, causes of the lesion, namely : i. compression of a bronchus by a tumour of some kind, usually aneurysmal or cancerous : ii. ulceration of a bronchus, and discharge thereinto of disintegrating material, mostly derived from caseous bronchial glands. The primitive pneumonic consolidation tends to ulceration and excavation, or to gangrene. Dilatation of the tubes is common.

§ I. Pneumonia due to compression of the bronchi. The signs relating to the affected lung are : dulness to percussion ; and, at first, weakness, in any degree up to total loss, of vocal thrill, vocal resonance, and breathing sounds. Later on, signs of excavation, altogether like those of phthisis, may appear ; bronchial breathing, bronchophony, and gurgling rales. The

diagnosis is from pleural effusion, or from tumour of the lung; and puncture is one of the means thereto.

§ II. Pneumonia due to bronchial ulceration.[1] Dulness to percussion over the lower or middle lobe of the lung: bronchial breathing, weak at first, becoming more and more cavernous: mucous rale, becoming more and more reverberating and gurgling towards the end of life: these are the physical signs. No unilateral distension of the chest, and no displacement of the mediastinum. The diagnosis from loculated empyema is often impossible, except by puncture.

The diagnosis of Pulmonary Gangrene, whatever be its cause, depends chiefly upon the characters of the sputa, namely, the fœtor, and the pulmonary elastic tissue to be seen by microscopic examination. When the patch of gangrene is large and single, the signs are those just narrated: when the gangrenous spots are many, small, and scattered through the lung (a result of embolism), the auscultation and

[1] S. Gee: On the chronic pneumonia which is associated with disease of the bronchial and tracheal lymphatic glands St. Bartholomew's Hospital Reports, vol. xiii. 1877.

percussion-signs are those of diffused catarrh. The diagnosis is from other diseases attended by stinking expectoration, namely: from local empyema (by puncture); from phthisis, which it is very difficult to distinguish from a circumscribed gangrenous cavity cleared of slough; from dilated bronchi, with or without surrounding consolidation of the lung; from mere bronchitis; and from an abscess of the bronchial glands, which opens into the air-tubes.

CHAPTER XIX.

EMBOLIC PNEUMONIA, OR PYÆMIC INFARCTUS.

¶ I. The physical signs are chiefly due to the attendent pleurisy: namely, friction sound over any part of the chest; or the signs of pleural effusion at the base, dulness to percussion and bronchial breathing.[1]

¶ II. The consolidation itself may be large enough to afford signs. A superficial infarctus, the size of a walnut, will yield, in a lean adult or a child, distinct dulness to percussion and bronchial breathing.

¶ III. Pneumothorax may follow the bursting of a pyæmic abscess.

[1] Plugging of a large pulmonary artery, by a dislocated venous thrombus, not pyæmic, has seemed to me to be followed by signs of oedema in the part of lung affected, when the patient recovered from the immediate shock of the embolism.

CHAPTER XX.

PULMONARY TUBERCULOSIS.

ACUTE or chronic pulmonary tuberculosis, if disseminated, that is to say, not going on to massive consolidation or phthisis, seldom affords physical signs which have any direct relation to the tubercle.

¶ I. The lesion is sometimes wholly latent; a most copious eruption of miliary tubercle being found after death in lungs which during life yielded no physical signs of disease whatever.

¶ II. Another form of the lesion is the bronchitic, the tubercles being either miliary or crude; and the signs, diffused over both lungs, are these: Percussion-note either unaltered, or somewhat raised in pitch, the resistence being increased at the same time. Breath sounds weak; sometimes faintly bronchial here and there. Mucous rales, which are sometimes sharp and reverberating, sometimes not: now and then, fine inspiratory crepitation. Signs of a more massive consolidation of a portion of the

lung are sometimes present. Indeed there are all degrees between the bronchitic form of tuberculosis and common phthisis.

¶ III. An acute pulmonary tuberculosis sometimes takes on a pneumonic form; that is to say, a massive tubercular consolidation occurs so rapidly as to afford crepitant rale, and most of the signs of lobar pneumonia.

CHAPTER XXI.

PULMONARY PHTHISIS.

BY pulmonary phthisis is meant massive tubercular[1] consolidation which tends to ulceration.

§ I. The physical signs of phthisis depend upon these particulars: the consolidation itself; diminished bulk of the solidified part; the localisation of rales in the solidified part; and the formation of cavities.

¶ I. i. Consolidation is indicated by diminution of percussion resonance; the pitch of the note rises and its clearness diminishes until, in some cases, absolute dulness is reached. ii. In the earlier stage of progressive solidification the respiratory sound is simply weak; later on, it becomes more and more bronchial. The bronchial breathing, which at first is due to consolidation of the spongy structure, afterwards becomes intensified by the formation of cavities.

[1] Or tuberculo-pneumonic, in the words of Thomas Addison: Works, p. 49.

In rare cases, when the solidification is very dense and massive, and not yet excavated, the respiration ceases to be audible at all.

¶ II. Diminution in the bulk of the solidified part occurs early in the disease, and is attended by contraction of the corresponding region of the chest. When the left upper lobe is affected, the superficial area of cardiac dulness will be increased. That form of phthisis which ends in grey induration,[1] affords the most marked shrinking of the chest: in these cases displacement of the mediastinum and of the heart, and elevation of the diaphragm occur.

¶ III. The fixed localisation of mucous rales in a limited portion of lung, is an early and important sign of phthisis. At first more or less obscure in proportion to the weakening of the respiration, the rales gradually become clear and reverberating as the consolidation and ulceration proceed.

¶ IV. The diagnosis of a cavity demands that it be near the surface, not smaller than a walnut, and containing for the most part air. i. Under these conditions the formation of a cavity is sometimes attended by a change of the previously dull percussion sound into a clear tone. When

[1] "Cirrhosis of lung": "fibroid phthisis."

this is the case, certain variabilities in the pitch of the tone have been noted. *a.* Wintrich observed that the pitch varied with the openness of the mouth; the more open the mouth, the higher the pitch.[1] But this variability is not peculiar to the clear tones of cavities; it may be afforded by lung simply relaxed. *β.* Gerhardt observed that the pitch varied with the position of the body.[2] The conditions of this sign seem to be two, namely, that the cavity be oval in shape, and that it be from a half to a third full of liquid. These things being so, if the longest diameter of the cavity be parallel with the axis of the body, the column of contained air will be shorter, and the percussion-note higher, in the sitting than in the lying posture. On the other hand, if the longest diameter of the cavity be transverse, from before backwards, to the axis of the body, the column of contained air will be longer, and the percussion-note lower, in the sitting than in the lying posture. Cavities

[1] Einleitung, p. 23.

[2] Ueber Differenzen des Percussionschalles der Lunge beim Sitzen und Liegen. Deutsche Klinik for 1859. p. 108.

Die Diagnose des grössten Durchmessers der Lungencavernen. Verhandlungen der phys. med. Gesellschaft in Würzburg. Neue Folge, vol. ix. p. 1. 1875.

which are round, or very irregular in shape, or which contain too much or too little liquid, will not yield this sign. ii. A large cavity is sometimes attended by a bulging of that part of the chest-wall which had previously been sunken. iii. The bronchial quality of the respiratory sound is always well marked in an empty cavity: the rales are large and resonating. iv. The veiled puff is believed by some to be a sign of cavity. v. Practically the physical diagnosis of excavation mostly comes to this, that, in progressive phthisis, a cavity is presumed to be present where the bronchial breathing is most intense. vi. Very large cavities may afford amphoric percussion-note, amphoric hum, metallic tinkling and splashing; but seldom a bell sound: indeed, all these amphoric signs are exceedingly uncommon in phthisis. Yet a phthisical cavity may be so completely cleaned out, and so distended with air, as to yield all the amphoric sounds, to displace the heart greatly, and to simulate pneumothorax almost indistinguishably. Having ended this general survey of the signs of phthisis I will now speak of a few additional matters.

§ II. i. The chest of persons predisposed to phthisis is usually phthinoid; and that of per-

sons actually phthisical, flat. Inasmuch as phthisis seldom involves both lungs to an equal extent, unilateral retraction of the chest is mostly present. A much more local shrinking commonly occurs where the phthisical processes are most advanced. Occasionally the thorax is of emphysematous shape: this is the case when phthisis is engrafted upon emphysema, or when emphysema follows retrograde phthisis. ii. Cracked-pot sound is sometimes begotten by percussion over phthisical consolidation, both when a cavity is present and when it is not. Clear tracheal resonance sometimes attends incipient phthisis, when there is no reason to suspect cavity; relaxation of the lung is probably present in such cases. iii. Sounds other than obvious rales, creaking and rubbing sounds, are not uncommon, and are most likely produced in the solidified tissues themselves; sometimes, however, undoubted transitory friction is heard. Collapse crepitation may be heard over phthisical lung. iv. The coexistence of a diffused pulmonary catarrh, of emphysema, or of laryngeal disease, is a great impediment to the physical diagnosis of phthisis. Generally speaking, the physician should examine a patient, supposed to be phthisical, several times before

giving a positive opinion. v. An aneurysmal dilatation of a branch of the pulmonary artery, contained in a phthisical cavity, has been known to give rise to shrill systolic murmur audible in the suprascapular fossa. Murmurs produced in the subclavian artery are not uncommon. vi. The respiration in the unaffected parts of the lungs is puerile, provided it be not modified by the presence of catarrh. The loudness of the puerile breathing sometimes leads the inexpert to predicate disease just in that one part where the lung remains healthy.

§ III. The difficulty of diagnosis between phthisis and some forms of pleurisy, pneumonia, and catarrh, has been already discussed. The diagnosis from pulmonary cancer and hydatid will be dwelt upon in the following chapters.

CHAPTER XXII.

PULMONARY CANCER.

¶ I. What has been said of pneumonia, tubercle, and phthisis, is true of cancer; that miliary disseminated consolidation cannot be distinguished by physical examination from simple catarrh.

¶ II. The signs of massive cancer are, in general, absolute dulness to percussion, diminished or absent vocal thrill, immobility of the chest on the affected side, and weak or absent breath-sound. When a large open bronchus is intimately connected with the cancerous mass, bronchial breathing will be heard.

¶ III. Cancer sometimes causes remarkable contraction of a whole lung: in such cases, pleural effusion almost necessarily follows. The physical signs are those of the effusion: but the diagnosis can sometimes be made by the discovery of two symptoms, namely; that the effusion is more or less bloody; and that large

hard glands are felt above the collar bone (on one or both sides) or in the armpit.

¶ IV. i. Cancerous solidification of the apex of one lung simulates phthisis, especially when the cancer breaks down into cavities.[1] Physical diagnosis in such a case becomes possible only when the cancer begins to involve the mediastinum, or to spread in any other manner unlike the phthisical process. ii. It has been already pointed out that very large cancerous tumours of the lung afford signs which for the most part closely resemble those of pleurisy with effusion. But cancer, unless of quickest growth, does not enlarge the chest, may even cause it to be retracted. The mediastinum and diaphragm are usually not displaced. Nevertheless, a quickly-growing tumour sometimes sprouts so as to displace the heart or depress the diaphragm. When dulness begins not at the bottom of the chest; when there is a great extent of absolute dulness in front, and none behind; when, in the midst of a great extent of dulness, we detect one or more small insulated patches of resonance (haply quite clear or even cracked-pot); we may

[1] J. R. Bennett: Lumleian Lectures on the natural history and diagnosis of Intrathoracic Cancer. Brit. Med. Journal. 1870, pp. 565 sqq.

debate the existence of a solid tumour. The crucial test is puncture. iii. Mediastinal cancer, and pericardial or pleural effusions often concur. iv. Cancerous tumour of the lung, near to the heart or aorta, may (like mediastinal tumour) pulsate, and also yield a systolic murmur, it is said.[1] In such a case, the diagnosis from aortic aneurysm might be very difficult.

[1] Stokes: A treatise on the diagnosis and treatment of diseases of the chest: p. 378. Dublin, 1837. Cancer of the upper lobe of the left lung, causing pulsation and murmur behind the manubrium sterni and its neighbourhood: the pulsation probably not in the vessels of the new-growth, but conducted from the pulmonary artery.

CHAPTER XXIII.

PULMONARY HYDATIDS.

¶ I. A HYDATID cyst may be buried so deeply within the lung as to be altogether beyond the reach of physical examination.

¶ II. A moderately large cyst is indicated by an area of percussion dulness not smaller than the palm of the hand, always rounded in shape, with a sharp outline, and situated most commonly in the lateral or infraclavicular regions.[1] Over this dull space the vocal thrill and breathing sounds are absent. Beyond the dull space, both percussion and breathing sounds are natural: portions of lung may be relaxed, just as in pleural effusion, so as to yield a percussion resonance unnaturally clear. Local hemispherical bulging sometimes occurs. Local friction also.

¶ III. A very large hydatid cyst will yield most of the signs of a partial or total pleural effusion, namely, unilateral distension of the

[1] S. Dougan Bird: already cited (p. 199).

chest, displacement of the diaphragm and mediastinum, dulness to percussion, and weak or absent breathing sound.[1]

Puncture of the chest is the most decisive means of diagnosis. The method has already been described (p. 199). Hydatid liquid escapes; unless the cyst have suppurated, in which case the diagnosis from empyema depends upon the detection of echinococcus hooklets or hydatid membrane.

¶ IV. The cyst often bursts into the air-tubes: hydatid fluid, hydatid membrane, blood or pus being expectorated. A large suppurating cyst, with a free opening into the bronchia, yields the signs and symptoms of pulmonary phthisis.[2]

¶ V. The cyst has been known to burst into both the bronchia and the pleura, and so to cause a hydropneumothorax.[3]

[1] Southey: Case in which a large hydatid cyst was removed from the chest. St. Barthol. Hospital Reports: vol. iii. p. 394. 1867.

[2] Greenfield: A case of hydatid of the lung. Clinical Soc. Trans. vol. x. p. 103. 1877.

[3] Case quoted from Mercier by Trousseau: Clinique Médicale, vol. i. p. 711. 2nd edit. 1865.

CHAPTER XXIV.

DILATATION OF THE BRONCHI.

¶ I. The physical signs afforded by a sacculated bronchus are almost identical with those of a phthisical cavity. The diagnosis depends upon the symptoms. The conditions needful for the discovery of a bronchial sac by percussion and auscultation are these : that the cavity be of a certain size, near the surface, surrounded by condensed lung, and containing air as well as liquid. Rapid change in the physical signs, consequent upon profuse expectoration, is important evidence of dilated bronchus.

¶ II. Sometimes the bronchiectasis is multiple, that is to say, many tubes in one or both lungs are dilated. In this case also, the diagnosis is from phthisis : and is rendered all the more difficult by the fact that numerous cavities, separated by condensed tissue, will yield an impaired percussion note.

CHAPTER XXV.

HYPERTROPHY OF THE HEART.

THE heart is said to be hypertrophied when the quantity of its muscular tissue is increased. The sign is a heaving impulse. Which is best felt at or just above the apex-beat when the hypertrophy affects the left ventricle; and a little to the left of the lower part of the sternum when the hypertrophy affects the right ventricle; of hypertrophy of the auricles there is no certain sign. The heaving impulse may be countervailed or concealed by conditions such as these; feeble action of the heart, degeneration of its texture, emphysematous lung over the heart, and very fat chest walls: wherefore heaving impulse is far from being a constant sign of hypertrophy. When the right ventricle is hypertrophied, the conducted epigastric impulse is strong. When the left ventricle is hypertrophied, the apex of the heart sometimes reaches farther to the left than natural, partly

perhaps in consequence of elongation of the aorta due to the hypertrophy.

A sharp whizz is heard in the arteries under a certain degree of pressure by the stethoscope; and the pulsation may be strong enough to raise the observer's head, at the same time.

CHAPTER XXVI.

DILATATION OF THE HEART.

¶ I. The signs of a dilated heart are these: i. Bulging of the heart region (p. 33). ii. Extension of the deep-seated area of cardiac percussion dulness, along a horizontal line; to the right when the right cavities, and to the left when the left cavities are dilated. The dull space usually remains oval in shape; a point upon which the diagnosis between an enlarged heart and a pericardial effusion greatly depends. Yet the deep dulness of a dilated heart may be sometimes extended upwards so as to reach the first left cartilage, and to assume a shape more or less triangular. iii. Another important sign of dilatation is this, that the apex-beat moves with the extension of dulness to the left; both sometimes reach to the left as far as the axillary line. iv. The enlarged heart tends to displace the lungs, and so to come into contact with a larger space of the chest-wall; hence an impulse more extensive than natural.

Fig. 22.

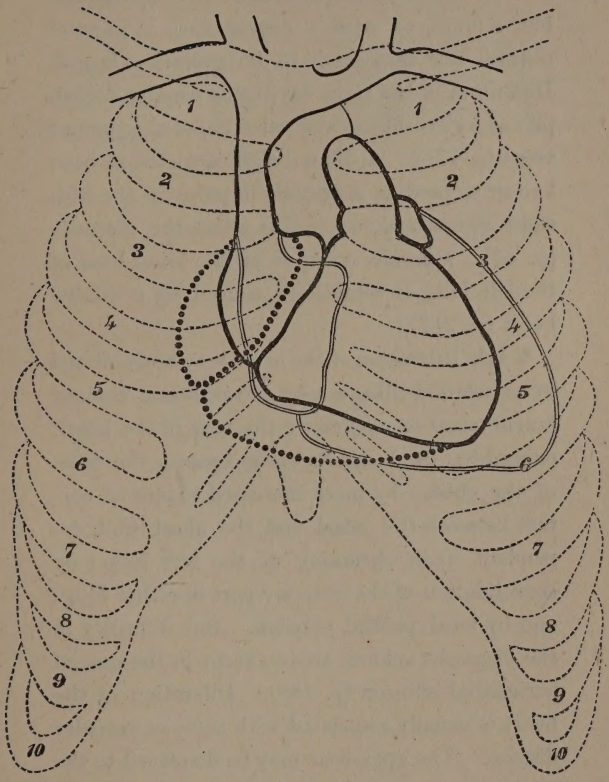


Diagram showing Dilatation of the Right Side and of the Left Side of the Heart: from Von Dusch.

¶ II. The diaphragm is depressed; sometimes, but seldom, to such a degree that a liver of natural size may seem to be greatly enlarged. Dilatation of the right cavities is usually accompanied by overfilling and pulsation of the jugular veins (p. 178). A dilated right auricle has been known to produce a systolic impulse in the fifth right interspace, two inches from the sternum (p. 45). Chronic collapse of the lower lobe of the left lung is sometimes caused by a dilated heart (p. 217).[1]

¶ III. Dilatation of the heart may be simulated by pericardial effusion; by intrathoracic tumour (aneurysmal or not) above the base of the heart, or pushing the heart forwards against the front of the chest; by mere increased extent of contact between the heart and the chest wall, dependent upon shrinking of the left lung; by consolidation of the anterior part of either lung; and by local pleural effusion. But difficulty in the diagnosis seldom arises except in the case of pericardial effusion (p. 288). Dilatation of the heart is usually associated with signs of valvular disease. The apex-beat may be displaced to the

[1] T. W. King: On a morbid flattening or compression of the left bronchus, produced by dilatation of the left auricle. Guy's Hosp. Reports, vol. iii. p. 175. 1838.

left, not only by dilatation of the left ventricle, but also by dilatation of the right heart alone, elongation of the aorta, displacement of the mediastinum to the left, and elevation of the diaphragm.

CHAPTER XXVII.

PERICARDITIS.

THE physical signs of pericarditis depend upon the inflammatory effusion into the pericardium. When the quantity of the exudation is small, it cannot be discovered, unless it cause a friction-sound (p. 168). For this reason, a friction-sound is usually the earliest sign of pericarditis. When the quantity of the exudation is large, it is discovered by means of percussion.[1] Disappearance of a friction-sound is due either to progressing liquid effusion, or to adhesion of the inflamed surfaces, or perhaps to absorption of the exudation. But friction is not always abolished even by a large liquid effusion. On the other hand, there will sometimes be no friction, even when the pericardium is full of coagulable lymph with very little serum. And lastly, pericarditis is sometimes wholly undiscoverable either by percussion or by auscultation: the lymph may be too soft to yield friction-

[1] See the next chapter.

sound, and a liquid effusion (even of some ounces) may lie behind the heart so as not to affect the area of its percussion dulness.

It is sometimes hard to decide whether friction-sound, heard over the heart region, is pleural or pericardial. Pleural friction may be developed by the movements of the heart alone, and pericardial friction may be under the influence of breathing movements (pp. 142, 169, 173).

CHAPTER XXVIII.

PERICARDIAL EFFUSION.

INCREASE in the area of cardiac dulness; this is the sign, not only of a dilated heart, but also of an effusion (of serum, pus, or soft and bulky lymph) into the pericardium. The two diseases however do not extend the area of dulness in the same manner; hence the means of diagnosis between them. I have already spoken of dilatation of the heart: it remains to describe the signs of pericardial effusion.

§ I. The first extension of percussion dulness occurs at the base of the heart, where the great vessels enter, and where the pericardium hangs loosely round them, and is most distensible. At the beginning, the dulness is increased chiefly upwards, so as to reach the second left rib, between the sternum and the parasternal line. A larger effusion will extend the dulness at the base transversely, so as to reach from the right side-sternal, or parasternal, line to the left

nipple line, and as high, it may be, as the first rib.[1]

Hitherto there will have been little change in the signs afforded by that part of the pericardium which is close upon the diaphragm. However, further increase in the fluid, after it has distended the pericardial sac around the vessels, will dilate the pericardial sac around the heart. Hence, progressive increase in the transverse dulness below the base of the heart, and corresponding displacement of the lungs, until, in an extreme effusion, the non-resonant space will reach from the right nipple line to the left axillary line, and up to the top of the manubrium sterni, the whole left front being dull. In all pericardial effusions, whether great or small, it is the upward extension of dulness which affords the chief means of diagnosis from enlargement of the heart.

§ II. Pericardial effusion may, as already said, lie wholly behind the heart, and be undis-

[1] Rotch : Absence of resonance in the fifth right intercostal space, diagnostic of pericardial effusion. Boston, 1878. Concludes, from experiments on the dead body, that "flatness, at from two to three centimetres from the right edge of the sternum in the fifth intercostal space, would be almost absolutely sufficient to mark the presence of an effusion."

coverable, even when there are no old adhesions in the sac to account for this peculiarity. Lung, emphysematous or not, and air-distended, lying in front of the pericardium, will obviously interfere with the development of percussion dulness, such as just described. Dulness behind the manubrium sterni is sometimes not present, even although the pericardium, distended with liquid and uncovered by lung, lie there: the reason being that the liquid conducts a clear note from the trachea or neighbouring lung. Acute dilatation of the heart's cavities sometimes concurs with pericarditis, and will, when associated with a small effusion around the vessels at the base of the heart, give the physical signs of a large effusion. Chronic dilatation of the heart will produce the same effect, when the pericardial sac is everywhere obliterated by old adhesions, except at the base around the large vessels, and an effusion takes place there.

§ III. When the effusion is limited to the base of the heart, the apex-beat and the left limit of dulness will correspond; but when the cardiac portion of the pericardium is distended by liquid, the dulness will reach beyond the apex-beat, and to the left of it. At the same time the impulse is weakened; it may finally

become imperceptible; in consequence of the separation of the heart from the front of the chest. An impulse, wholly impalpable in the lying posture, may be well felt in the erect. Bulging of the heart region is consequent upon a large pericardial effusion as well as upon a dilated heart, especially in the young. In a few cases of excessive distension, a sort of undulation has been seen; comparable with pulsating empyema.

§ IV. The lung around a distended pericardium is relaxed. A large effusion sometimes exerts an amount of pressure upon the bronchi, especially the left, such as to cause more or less collapse of the corresponding lung (pp. 217, 280). Great bulging of the left lung-apex above the clavicle, dependent upon pericardial effusion has been noted.[1] The cervical veins are sometimes very full. The diaphragm is depressed, and therewith the liver and the spleen.[2] Seldom is the depression so great as to produce a swelling of the epigastrium.[3] The diaphragm may be paralysed; if it be, the epigastrium sinks inwards during inspiration.

[1] Graves: Clinical Lectures, 2nd edit. vol. ii. p. 176. 1848.

[2] Senac: Traité, 2nd edit. vol. ii. p. 364. 1783.

[3] Auenbrugger's Inventum Novum, § 46.

§ V. The diagnosis is from dilatation of the heart; aneurysms, abscesses, or other mediastinal tumours; consolidation of the front parts of the lung; and pleural effusion. i. From dilatation of the heart the diagnosis depends mainly upon the different shapes of the area of percussion dulness in the two diseases. Yet it cannot be denied that a dilated heart sometimes yields that upward extension of dulness which is the chief note of pericardial effusion: hence the instances, not very few, wherein the heart has been pierced in an attempt to draw off a non-existent pericardial effusion. So that the whole history and all the physical signs must be pondered in a difficult case. The combination of dilated heart and pericardial effusion has been already spoken of (p. 286). Puncture of the pericardium is never performed as a mere means of diagnosis. ii. From aneurysmal and mediastinal tumours the diagnosis depends upon a careful comparison of all the physical signs of the two diseases. Pericardial effusion seldom affords the signs of pressure upon the innominate veins or recurrent laryngeal nerves. iii. From consolidation of lung the diagnosis depends mainly upon the auscultation signs. iv. Loculated pleural effusion, situated exactly

over the heart and only there, seldom or never occurs. But a large effusion into the left pleura only may cause a bulging of the chest in the heart region, such as to raise the question of a concurrent pericardial effusion : for pleurisy on the left side and pericarditis are often associated. The diagnosis depends mainly upon the result of paracentesis, and emptying the left pleura, whereby alone can the signs of a pericardial effusion become manifest.

CHAPTER XXIX.

PNEUMOPERICARDIUM.

THE percussion note, over the heart region, is clear (or even amphoric) when the patient is lying: when he sits up or leans forward, the sound becomes dull. A cracked-pot sound has been noted.

The auscultation signs are these:

i. Amphoric quality of the heart sounds.

ii. Friction sound, if present, acquires the character of metallic tinkling.[1]

iii. When the pericardium contains liquid as well as air, the water-wheel sound (p. 170) is heard. It is sometimes so loud as to hide the heart sounds, or even to be audible without auscultation.

iv. Succussion splash has been heard in cases of the same kind.

[1] Graves: A system of clinical medicine, p. 824. Dublin, 1843. A case of hepatic abscess which opened into both stomach and pericardium.

CHAPTER XXX.

ADHERENT PERICARDIUM

THERE are no certain signs of adherent pericardium.[1] When the pericardium adheres not only to the heart within, but also to the walls of the chest in front and to the spinal column behind, the following signs may be present. i. Systolic recession of the apex-beat, associated with a weak impulse: a sign which even if well marked cannot be wholly depended upon (p. 46). ii. Deep inspiration does not diminish the area of superficial cardiac dulness: does not depress the apex-beat: and is attended by recession of the epigastrium, consequent upon the fixedness of the pericardial portion of the diaphragm. iii. Diastolic collapse of distended jugular veins (p. 183).

[1] The latest monograph upon this topic is by Riegel: Die Diagnose der Pericardialverwachsung. Volkmann's Sammlung, no. 177. 1879.

CHAPTER XXXI.

MITRAL REGURGITATION.

¶ I. A MURMUR, replacing or immediately following the first sound, and heard louder at or just above the apex-beat than over any other part of the heart region, indicates regurgitation through the mitral orifice. The murmur is often heard well at the angle of the left scapula: is sometimes louder there than at the apex-beat; is sometimes indeed heard at the angle of the scapula only, and not at all at the apex-beat. The murmur is often heard well, or even heard loudest, over the third left cartilage, at one or two inches from the left edge of the sternum: behind which spot lies the tip of the left auricular appendix, whereinto the murmur is supposed to be conveyed by the regurgitation.[1] The murmur is sometimes heard over a very

[1] Naunyn: Ueber den Grund, wesshalb hin und wieder das systolische Geräusch bei der Mitralisinsufficienz am lautesten in der Gegend der Pulmonalklappen zu vernehmen ist. Berlin, klin. Wochenschr: no. 17. 1868.

small space at the apex-beat, and nowhere else.

¶ II. Incompetence of the mitral valve is not always attended by a murmur: this is especially the case when the heart is much dilated and unable to contract upon its contents: wherefore mitral murmur often disappears before death. Moreover, under any circumstances, mitral murmurs are of all murmurs most variable:[1] they disappear and reappear in an inexplicable manner; and this, even when they are due to structural changes in the valvular cusps.

¶ III. Mitral regurgitation is far from being always due to valvular disease. The murmurs, which occur in oligaemia and general debility, often possess the characters of mitral regurgitant murmurs. They were formerly included in the class of murmurs which were called functional, inorganic, or haemic, and which were supposed to be produced at the pulmonary orifice, because heard over the third left cartilage: but we now know that mitral murmurs may be well heard at this spot. These murmurs are most likely due to debility of the heart's

[1] Sanders: On the variation and vanishing of cardiac organic valvular murmurs. Edinb. Med. Journal, vol. xiv. p. 584. 1868—9.

muscular tissue. The normal closure of the auriculo-ventricular orifices is not wholly effected by the valvular cusps, but is partly due to a sphincter-like action of muscular fibres which surround the orifices.[1] When these fibres are weakened, the valves are closed imperfectly, and regurgitation occurs. Murmurs, not due to disease of the cusps, are usually temporary, and disappear when the bloodlessness or general weakliness disappears : the muscular tissue being supposed to recover its tone. But this is not always the case : dilatation of the heart sometimes accompanies the murmur,[2] and like the murmur is mostly temporary ; but sometimes the dilatation is permanent, progressive, causes death sooner or later ; and when the heart is examined post mortem it is found simply dilated, the valvular cusps being natural but too small to close the widened orifice.

¶ IV. Permanent mitral regurgitation produces hypertrophous dilatation of the left cavities of the heart, congestion of the lungs, and lastly dilatation of the right cavities.

[1] Ludwig and Hesse : quoted by MacAlister : Remarks on the form and mechanism of the heart. Brit. Med. Journal, Oct. 28, 1882.

[2] West : On some forms of dilatation of the heart. St. Bartholomew's Hosp. Reports, vol. xvii. p. 195. 1881.

CHAPTER XXXII.

MITRAL OBSTRUCTION.

¶ I. A MURMUR, after the second sound and before the first, heard louder at the apex-beat than over any other part of the heart region, indicates obstruction at the mitral orifice.[1] The murmur is usually præsystolic, that is to say, it is immediately followed, without any interval, by the first sound. The murmur is sometimes undoubtedly diastolic, that is to say, it immediately follows the second sound; there being a distinct interval between the murmur and the first sound. The murmur is sometimes so prolonged as to fill up the whole time between the second and first sounds. The murmur is sometimes double, both diastolic and præsystolic, with a distinct interval between its two parts.

[1] The connection between præsystolic murmurs and mitral obstruction was discovered by Fauvel: Mémoire sur les signes stéthoscopiques du rétrécissement de l'orifice auriculo-ventriculaire gauche du cœur. Archives gén. de Méd., series iv. vol. i. p. 1. 1843.

The murmur, whether præsystolic or diastolic, is seldom heard at the angle of the scapula.

¶ II. A præsystolic murmur sometimes passes indistinguishably into a systolic murmur (due to associated regurgitation); sometimes the first sound is well heard between the præsystolic and systolic murmurs; but usually a loud first sound is heard, and no systolic murmur. A diastolic murmur is mostly attended by a systolic murmur. A systolic murmur will sometimes be heard at the angle of the scapula (or indeed all over the back) when the only murmur audible at the apex-beat is præsystolic. In a case of this sort, I found that the middle line of the axilla exactly separated the areas of the two murmurs. The murmur attending mitral obstruction is sometimes undoubtedly systolic only; that is to say, the murmur proper to the obstruction is not heard, but only the concomitant regurgitant murmur. The first sound is loud, and mostly seems to put a sudden stop, as it were, to the præsystolic murmur. The second sound is usually, but not always, inaudible at the apex-beat.

¶ III. The murmur of mitral obstruction may be variable: for instance, a præsystolic murmur, followed by a loud first sound and no

second sound, may give way for a time to a systolic murmur with first and second sounds: then the præsystolic murmur will reappear, while the systolic murmur and the second sound vanish.[1] All murmurs will disappear when the heart is exhausted and unable to expel its contents: in this state, the first sound also usually disappears. The influence of posture upon præsystolic murmurs has been already discussed (p. 161): no examination of the heart is complete if the patient have not been ausculted in both upright and lying posture. Lastly, the murmur sometimes disappears in a manner which cannot be explained.

¶ IV. A thrill often attends the murmur: either præsystolic and running up into the impulse; or diastolic, alternating with the impulse, and accompanied with a back stroke.

¶ V. A mitral præsystolic murmur is always due to permanent structural disease of the valve. Mitral and tricuspid obstruction often concur. In mitral obstruction, overfilling of the left auricle and pulmonary congestion are carried to a high degree. Hence hypertrophous dilatation of the left auricle, and dilatation of the right heart.

[1] See note on page 324.

CHAPTER XXXIII.

AORTIC REGURGITATION.

¶ I. A MURMUR, replacing or immediately following the second sound, and heard at the second right interspace and along the sternum, indicates regurgitation through the aortic valve.[1] i. The second sound is sometimes well heard at the second right interspace: even when this is not the case, the second sound is usually heard at the second left interspace. ii. The murmur is often best heard at the lower end of the sternum (and especially a little to the left thereof). iii. The murmur is often, but certainly not always,

[1] Incompetency of the aortic valves was known to morbid anatomists long before the discovery of auscultation. Hodgkin seems to have been the first to discuss the lesion from the clinical point of view. His papers, "On retroversion of the valves of the aorta," were read before the Hunterian Society on February 21st, 1827, and February 18th, 1829, and were published in the Lond. Med. Gazette for March 7th, 1829. See Wilks: Note on the history of valvular diseases of the heart: Guy's Hosp. Reports, series iii. vol. xvi. p. 209. 1871. Hodgkin mentions the diastolic murmur, which Corrigan, in his paper, published in 1832, does not.

conducted to the apex: is sometimes heard there better than elsewhere. iv. The murmur is often conducted into the arteries near the heart, the carotids and subclavians, so as to be well heard below both clavicles: but this is not always so. v. The murmur is sometimes best heard over the second left interspace or third left cartilage. This means that the heart is displaced to the left; most likely in consequence of elongation of the aorta; the apex-beat will be found to the left of the nipple line. The diagnosis of such cases depends much upon the characters of the pulse. vi. The murmur sometimes possesses a loud whining or cooing character; and will be audible in all the larger arteries, even so far away as the radials;[1] all over the front of the chest; in the left axilla, and at the angle of the left scapula; by the ear placed nigh to, but not upon, the chest; and lastly, by the patient himself. vii. A systolic basic murmur also is commonly present: or at any rate the first sound is not clear. This systolic murmur is certainly not always due to obstruction at the mouth of the aorta, but is probably sometimes the result

[1] Watson: Principles and practice of physic: 4th edit. vol. ii. p. 275. And I have observed a case of this kind myself.

of a mere relative constriction of the orifice, connected with positive dilatation of the ascending aorta. viii. The diastolic murmur may disappear when the heart falls into a state of asystoly, or inability to expel its contents.

¶ II. A diastolic thrill, at the second right interspace, is sometimes present. In the displacement of the heart to the left just spoken of, the thrill may be felt in the second or third left interspace.

¶ III. Just as mitral diseases tend to be followed by pulmonary congestion and enlargement of the right heart, so do aortic diseases bring after them hypertrophy of the left ventricle. Hence the heaving impulse, mostly but not always present. Hence the frequency of dilatation of the ascending aorta; the elongation of the arteries; and the intensity of the arterial systolic murmur. Diastolic arterial murmur (p. 177) is often present. But above all these arterial signs, a jerking pulse is the most important help in diagnosis.[1] Yet the heaving

[1] "Après avoir remarqué l'abattement de ses yeux, la bouffissure, et la pâleur de son visage, j'examinai son pouls qui me parut fort plein, fort vîte, dur, inégal, et si fort que l'artère de l'un et l'autre bras frappait le bout de mes doigts autant que l'auroit fait une corde fort tendue et

impulse, and all the arterial signs are sometimes not present, even when a distinct diastolic murmur in the aortic region renders the nature of the disease quite certain.[1]

¶ IV. A result of aortic regurgitation, less common than hypertrophy of the left ventricle, is dilatation thereof. In which case the mitral orifice partakes in the dilatation; and becomes regurgitant; the cusps remaining unchanged: all the results of mitral regurgitation follow. The aortic and mitral valves are often simultaneously diseased, so that the flaps of both valves are altered in structure.

¶ V. The diastolic murmur, the signs of hypertrophy of the ventricle, and the peculiar jerking pulse, are the most important signs of aortic regurgitation. But cases have been ob-

violemment ébranlée." Histoire de Jean Chifort (case of disease of aortic sigmoids) : Vieussens. Œuvres françoises, 1715.

[1] Stoll has noted the coincidence of aortic regurgitation and sudden death. In the sixteenth post-mortem examination described in Ratio Medendi, vol. i., Vienna, 1777, the aortic sigmoids were found so much diseased as to be quite incapable of closing the valvular orifice : "Mortem repentinam ab aucto humorum ad cor allapsu deduximus, qui ab osseo aortæ capite, valvulisque ferme ex toto rigidis expediri promoverique ulterius nequiverant."

served[1] of an aortic diastolic murmur heard during life, not to be explained by any lesion of the aortic valve found after death. In all, however, the aorta has been unnaturally rigid, if not dilated. Marey[2] declares that the cardiograph affords the only means of diagnosis; a sign peculiar to aortic regurgitation being a too rapid ascent of the traced line between the second sound and the auricular systole, indicative of a too rapid filling of the ventricle.

[1] By Cruveilhier, Vulpian, Gubler, Fournier: see Edinb. Med. Journ. vi. p. 471.

[2] Notes sur un nouveau signe de l'insuffisance aortique. Gaz. Méd. de Paris, no. 38. 1868

CHAPTER XXXIV.

AORTIC OBSTRUCTION.

¶ I. The murmur present in cases of aortic obstruction is systolic, and heard loudest in the second right interspace. But many of the murmurs commonly called functional or inorganic possess these characters. Wherefore it is necessary to the diagnosis of aortic obstruction that the murmur be loud and long, and attended by a heaving impulse indicative of hypertrophy of the left ventricle, and by a pulse which is small even when the heart is beating strongly: moreover the signs of aneurysm must be absent. A systolic thrill, felt on the right side of the base of the heart, is often present. Aortic obstruction is usually complicated with regurgitation; even when there is no diastolic murmur, the aortic second sound is muffled, weakened, or absent.

¶ II. The murmurs which simulate aortic obstructive murmurs, being systolic, heard over the second right cartilage, and yet not due to

any disease of the valve, have never been satisfactorily explained. The most likely hypothesis has been already discussed (p. 166). It is in states of debility, or during fits of palpitations, that inorganic systolic aortic murmurs are heard. They are always soft; and cease with the debility or the palpitations, as the case may be.

CHAPTER XXXV.

TRICUSPID REGURGITATION.

¶ I. A MURMUR, systolic, and heard best over the lower part of the sternum, or a little to the left thereof, may be due to tricuspid regurgitation. The valvular disease is mostly consequent upon dilatation of the right side of the heart, which is secondary to impeded circulation through the lungs, whether the primary impediment be in the lungs themselves (for instance, when they are emphysematous), or in the left side of the heart (especially in mitral disease). But commonly it is only when the distension of the orifice is great that the murmur becomes audible: and a greatly dilated heart usually contracts weakly: hence, in most cases of tricuspid regurgitation, there is no corresponding murmur. The murmur is not conducted far from the spot mentioned; is not heard in the back: and sometimes is not heard in the upright, but in the lying posture only.

¶ II. The important signs of tricuspid regur-

gitation, which the jugular veins usually, but not always, afford, have been already described (p. 178). A systolic thrill at the epigastrium is said to have been present in a few cases. The associated dilatation of the right heart cannot always be made out by percussion, because of the pulmonary emphysema.

¶ III. The temporary murmurs of bloodlessness and weakliness may possess the characters of tricuspid regurgitant murmurs.[1] The most likely cause of temporary regurgitation through the auriculo-ventricular valves has been already set forth (p. 294). A murmur sometimes occurs in lying-in women for a short time, and usually simulates, if it be not due to, tricuspid regurgitation.[2]

[1] Parrot : Etude clinique sur le siége et le mécanisme des murmures cardiaques dits anémiques. Arch. Gén. de Méd. series vi. vol. viii. p. 129. 1866.

[2] Money : On the great frequency of cardiac murmurs in the puerperal state. Med. Chir. Trans. vol. lxv., p. 87 1882.

CHAPTER XXXVI.

TRICUSPID OBSTRUCTION.

¶ I. An uncommon disease: the diagnosis whereof depends upon the following conditions.[1] A murmur, heard within a triangular area thus defined: the perpendicular corresponds with the right border of the sternum and ensiform cartilage, from the fourth right chondrosternal joint downwards: the base is a horizontal line drawn from the tip of the ensiform cartilage to the sixth left chondrocostal joint: and the hypotenuse is a line drawn from the fourth right chondrosternal joint to the sixth left chondrocostal joint. The murmur is præsystolic.

¶ II. A præsystolic thrill may be felt over the same area. The heart's percussion dulness is much extended to the right, because of the dilatation of the right auricle consequent upon

[1] Bedford Fenwick: On tricuspid stenosis: Lancet, 1881, vol. i. pp. 653 sqq.: has collected all the recorded instances (forty-six) of tricuspid obstruction; the details given above are a summary of his paper.

the tricuspid disease. The jugular veins are distended.

¶ III. Tricuspid obstruction is always attended by mitral obstruction: and, in half the cases, by aortic disease, regurgitant or obstructive. Eight-ninths of the subjects of tricuspid obstruction are female.

CHAPTER XXXVII.

PULMONARY REGURGITATION.

¶ I. This, the most uncommon of all valvular diseases, is attended by a diastolic murmur, heard loudest in the second left interspace and along the sternum.

¶ II. A diastolic thrill is sometimes present. A systolic murmur, not due to obstruction, occurs in pulmonary regurgitation just as in the corresponding aortic disease. Both murmurs are sometimes loud enough to be heard all over the heart region, and yet are not heard to the right of the sternum over the second interspace.

¶ III. Hypertrophy of the right ventricle, and impeded systemic venous circulation, with dilatation and pulsation of the jugulars, are secondary consequences.

CHAPTER XXXVIII.

PULMONARY OBSTRUCTION.

¶ I. The murmur of pulmonary obstruction is systolic, and heard loudest on the third rib, or in the second or third left interspace, close to the sternum.[1] A systolic thrill may be felt at the same spot. A loud murmur will be conducted far in all directions, even to the back. Hypertrophy of the right ventricle supervenes; so that it is not until the obstruction becomes great, or the heart's contractions begin to fail in vigour, that there is any stagnation in the general venous system.

¶ II. Murmurs, not due to any disease of the pulmonary valve, often assume the time and place indicative of pulmonary obstruction. Sometimes they can be explained by the pressure of solidified lung (phthisical or pneumonic) upon the artery: sometimes pressure by the stethoscope produces the murmur, especially in

[1] Ormerod: On a systolic murmur in the pulmonary artery. Edin. Med. and Surg. Journ., no. 166. 1846.

patients with a phthinoid chest (p. 162); but mostly the murmur cannot be thus explained.[1] Especially in conditions of debility and bloodlessness, do these (like all such) murmurs occur, which are not dependent upon endocarditis acute or chronic. Perhaps they are due to relative dilatation of the pulmonary artery (p. 166).

[1] Latham : Diseases of the heart : Lecture iii., 2nd edit. vol. i. p. 65. 1846.

CHAPTER XXXIX.

MALFORMATIONS OF THE HEART.

CONGENITAL malformation of the heart is usually discovered easily enough; but not so the precise kind of malformation. We may attempt a diagnosis for which our data are mostly insufficient, but we shall seldom advance beyond a guess.

i. The heart region is sometimes bulged, especially in older patients. ii. The impulse is often heaving, often diffused, sometimes hardly palpable. iii. The apex-beat is commonly displaced to the left, and is also lower than natural. iv. Extension of percussion dulness to the right is not uncommon. v. A murmur, systolic, and heard loudest over the pulmonary region (from the second to the third left interspace, close to the sternum), is common: the murmur is very local, or heard over the heart region, or conducted more or less extensively over the chest. Much less common murmurs are these: diastolic in pulmonary region, with or without systolic:

systolic at left apex : systolic at epigastrium, or just above and to the left thereof : and probably others which I have not met with. Sometimes the murmur disappears just before death. Sometimes there is no murmur at all. vi. A thrill often, not always, coincides with the murmur; being best felt where and when the murmur is loudest; and being very local or conducted more or less widely. vii. Signs in the jugular veins are uncommon.

Perforation of the upper part of the septum ventriculorum is supposed[1] to be indicated by a long murmur, beginning with the systole, and covering both sounds of the heart, which are nowhere to be heard. The murmur is loudest about the middle of the heart, and is conducted widely and equally in all directions. The murmur is attended by a thrill, but by no other signs of heart disease.[2]

Permanent openness of the ductus arteriosus

[1] Roger : Recherches cliniques sur la communication congénitale des deux cœurs, par inocclusion du septum interventriculaire. Bulletin de l'acad. de méd. 2me série : vol. viii. p. 1074. Oct. 21, 1879.

[2] A specimen in St. Bartholomew's Museum (no. 1320) seems to show that a murmur possessing all these characters may be due to constriction of the orifice of the pulmonary artery, apart from any perforation of the ventricular septum.

is believed to beget a murmur; but its characters are by no means determined.[1]

Permanent openness of the foramen ovale is thought to be attended by a murmur (p. 154).

[1] Hilton Fagge: A case of patent ductus arteriosus attended with a peculiar diastolic murmur. Guy's Hospital Reports, series iii. vol. xviii. p. 23. 1873. Murmur, throughout greater part of diastole, over second left costal cartilage close to sternum.

Greenhow: Case of phthisis and patent ductus arteriosus attended by a thrill and two murmurs. Clinical Society's Trans. vol. ix. p. 152. 1876. Murmur, throughout whole of diastole, over second left intercostal space close to sternum, inaudible in back.

François-Franck: Sur le diagnostique de la persistance du canal artériel. Gazette hebdom. Sept. 13, 1878. Murmur, systolic, in left interscapular region opposite third and fourth dorsal vertebræ, inaudible elsewhere.

CHAPTER XL.

MEDIASTINAL TUMOURS:

INCLUDING tumours developed in the connective tissue, abscesses, and enlargement of the thymus, or of the bronchial glands. i. A large and quickly-growing tumour, or abscess, sometimes causes protuberance of the front of the chest in the neighbourhood of the sternum: and this swelling may pulsate with the pulsations of the aorta, and so simulate an aneurysm. ii. The heart may be displaced downwards, upwards, or to either side; or may be pressed forwards. iii. Dulness to percussion will exist over a tumour which is in contact with the chest-wall, either in front, behind, and alongside the sternum; or behind, displacing one or other lung: except that small tumours, connected with the trachea or a bronchus, will afford a clear, tracheal note. iv. The tumour, when small, conducts sounds generated in its vicinity or not; bronchial breathing, bronchophony, and the heart's sounds: when large, there is no sound

to be heard over the tumour. v. Sometimes a systolic murmur at the base of the heart is produced by the pressure of the tumour, and so an aneurysm may be simulated. vi. The signs of obstruction to the large veins are common. vii. Signs of obstruction to the trachea or a bronchus;[1] of collapse of the lung; of destructive or gangrenous pneumonia; of pleurisy with effusion; and of pericarditis; may be expected. viii. The tumour, or abscess, or secondarily enlarged glands, may be felt above the collar bone. ix. With regard to disease of the thoracic lymphatic glands, I would say that there are no physical signs of scrofulous (tuberculous) disease of the bronchial glands (strictly so-called), namely, those in the roots of the lungs and the bifurcation of the trachea: whereas, disease of the tracheal glands often affords dulness to percussion alongside the manubrium sterni, and sometimes a swelling to be felt deep in the neck, behind the clavicle. The glands are more prone to disease on the right side of the trachea than on the left.

[1] Other important signs, such as those of compression of the inferior laryngeal nerve, do not fall within the scope of this book. Nor have I said anything about auscultation of the œsophagus, because, although I have often practised it, I cannot say that I have found much help from it hitherto.

CHAPTER XLI.

ANEURYSM OF THE THORACIC AORTA.

§ I. Aneurysms of the thoracic aorta must attain a size sufficient to bring them into contact with the chest-wall before they yield any physical signs directly dependent upon the aneurysm itself. Earliest to appear are the signs afforded by palpation and percussion.[1]

¶ I. By Palpation are detected pulsations and thrills. The Pulsation is systolic, synchronous with the latter part of the impulse of the heart. A slight diastolic shock, or even a strong diastolic impulse, may sometimes be felt over an aneurysmal tumour. When the aneurysm contains much coagulum, the pulsation is weak or even absent. i. Aneurysm of

[1] Aneurysm of a Valsalvian sinus seldom affords distinctive physical signs. Pulsating tumour is present in about seven per cent. of the cases, one half being to the right, and one half to the left of the sternum. Murmur is common, and due to regurgitation through the aortic or pulmonary valves. Sibson: The aorta and the aneurisms of the aorta: reprinted from "Medical Anatomy, fasciculus v." 1858; p. 2.

the ascending aorta touches the chest-wall first in the second right interspace close to the sternum : as the tumour enlarges, the pulsation extends upwards towards the clavicle and manubrium sterni, or downwards along the right margin of the sternum, haply as low as the fourth, or even fifth, interspace. ii. Aneurysm of the transverse aorta first comes to the surface behind the upper part of the sternum, and afterwards extends far away towards the left. iii. Aneurysm of the descending aorta, at its upper part, points below the first left rib, and thence extends downwards to the second space. iv. Aneurysm of the lower part of the thoracic aorta lies upon the left side of the dorsal vertebræ and may cause pulsation there. The site of pulsation sometimes is also the site of systolic or diastolic Thrill.

¶ II. By Percussion, dulness may be discoverable in the same situations : namely, behind the second and third ribs along the right side of the sternum ; behind the manubrium sterni ; to the left side of the sternum ; and along the left side of the dorsal vertebræ. The aneurysmal dulness is sometimes continuous with the cardiac dulness, sometimes not.

¶ III. By Inspection, a tumour upon the

surface of the chest is sometimes detected. The position of the tumour corresponds with that of the palpation and percussion signs. The shape of the tumour is hemispherical, except that it is sometimes nodular when it is constricted by resistent fibres in the overlying parts, or where the aneurysm itself is nodular. An aneurysmal tumour of the descending aorta may be so great as to push the scapula outwards.

¶ IV. By Auscultation there will be discovered a first and second sound, or a systolic and diastolic murmur, or a first sound and diastolic murmur, or a systolic murmur and a second sound, or a single sound or murmur, or no kind of sound at all. The sounds are probably those of the heart conducted: the systolic murmur is due to the passage of blood through a relatively narrow mouth into a wider cavity, whether an aneurysmal sac or a dilated aorta: the diastolic murmur is either a conducted murmur produced at the mouth of the aorta, or is due to the passage of blood out of a sac, or is inexplicable. The murmurs, when loud, may be conducted far away, along the arteries.

§ II. Uniform dilatation of the ascending aorta is attended by extension of percussion dulness to the right of the margin of the sternum,

on the level of the second and third cartilages, and behind the manubrium sterni. Elongation of the arch of the aorta forces the base of the heart downwards and to the left; in which case the apex-beat comes to be lower and more external than natural.

§ III. An aneurysmal tumour, like other mediastinal tumours, will compress neighbouring viscera. i. Pressure upon the trachea causes noisy breathing (stridor), audible at a distance from the patient. ii. Pressure upon the bronchus, commonly the right, also causes stridor: by auscultation, the sound will be loudest where the second rib joins the sternum. iii. Pressure upon the root of the lung may produce collapse, dilated bronchi, or destructive pneumonia (p. 258). iv. Pressure upon the spongy structure of the lung produces relaxation or collapse of the part involved. v. Pressure upon the vena cava superior or vena innominata is attended by the appropriate signs of venous obstruction. vi. The heart is liable to sundry displacements, thus: dilatation of the ascending aorta usually implies elongation thereof, whereby the heart is forced downwards and to the left: a large tumour of the transverse aorta produces the same effect: a very large tumour of the

descending aorta will push the heart towards the right: a tumour behind the heart will press it against the front wall of the chest.

§ IV. Anastomotic aortic aneurysms; that is to say, those which open into a neighbouring part of the circulating system. i. Into the vena cava superior: the signs are those of aortic aneurysm and venous obstruction, together with a strong systolic thrill and murmur in the veins of the neck, and haply a thrill and loud systolic murmur at the second right cartilage. ii. Into the right auricle: no signs more definite than those of an aortic aneurysm and of venous obstruction. iii. Into the right ventricle: no definite signs. iv. Into the pulmonary artery: systolic and long diastolic murmur at fourth left rib; no natural sounds there; diastolic thrill at the same spot; diastolic murmur inaudible at the apex-beat; pulsation and thrill in the carotids (p. 167).

§ V. Aortic aneurysms are simulated by pulsating solid tumours (p. 315), pulsating mediastinal abscesses (ibidem), and pulsating empyema (p. 248). Aneurysms, which do not pulsate and which are silent, simulate tumours of another kind.

CHAPTER XLII.

OTHER INTRATHORACIC ANEURYSMS.

§ I.—ANEURYSM OF THE INNOMINATE ARTERY.

¶ I. Dilatation of the part of the artery nearest to the heart is always associated with aneurysm of the ascending aorta, and is not attended by any distinctive signs.

¶ II. Dilatation of the distal part of the artery affords these signs following: i. A pulsating tumour, which comes up, between the origins of the sterno-mastoid muscle, from behind the right sterno-clavicular articulation, is due to an innominate aneurysm; provided there be no signs of aortic disease. For aortic aneurysm may rise into the same position. The head of the clavicle may be dislocated. ii. If there be, over the tumour, a systolic murmur, it is conducted into the right carotid, but not into the left. iii. Pressure upon one or both of the innominate veins is common.[1]

[1] Cockle: Contributions to the Pathology of Aneurisms and Tumours, involving the upper portion of the Chest and Root of the Neck. Medico-chir. Trans., vol. 50, p. 459. 1867.

§ II.—ANEURYSM OF THE PULMONARY ARTERY.

A very uncommon disease, seldom discoverable during life. Yet these signs are said to have been noted: i. More or less swelling about the second and third left interspaces, nigh the sternum. ii. Systolic, and sometimes diastolic impulse there. iii. Some dulness to percussion. iv. Very loud sounds or murmurs, especially systolic, in the same place. v. Consecutive lesions relate to the right, rather than to the left, heart.

NOTE TO PAGE 297.

The bruit de rappel, described on p. 165, is a sign of mitral obstruction. The bruit de rappel alternates, in some cases, with a diastolic apex murmur : that is to say, a prolonged diastolic murmur, which is the more constant sign of a mitral obstruction, will disappear from time to time, and be replaced by a well-marked bruit de rappel.

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